4 Oecon. 78-1

<36605279780019

<36605279780019

Bayer. Staatsbibliothek

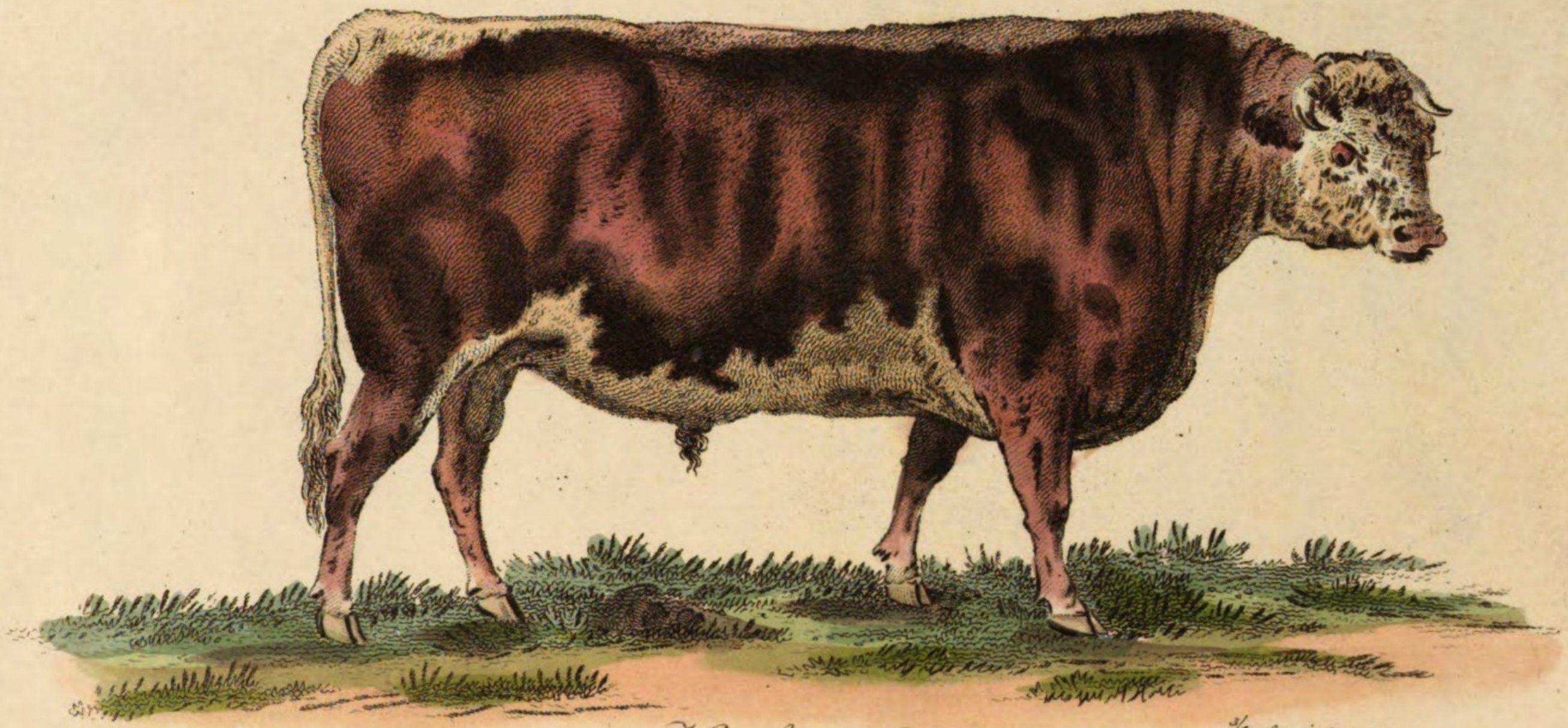
4 Oecon. 78-1

Oeconomica. Agricultura. Systemata et methodi

210.

~~Oecon. agrar. No. 49~~

R



G. Garrard del.

3/4 of an inch to a foot.

Hereford Bull.

Printed for Richard Phillips, 71, St. Paul's Church Yard, Oct.r 23. 1804.

PRACTICAL

AGRICULTURE;

OR,

A COMPLETE SYSTEM

OF

MODERN HUSBANDRY:

WITH THE

METHODS OF PLANTING,

AND THE

MANAGEMENT OF LIVE STOCK.

BY R. W. DICKSON, M. D.

..... Pater ipse colendi
Haud facilem esse viam voluit. VIRG. GEORG. LIB. I.

IN TWO VOLUMES.

VOL. I.

LONDON:

PRINTED FOR RICHARD PHILLIPS, No. 71, ST. PAUL'S CHURCH-YARD;

BY R. TAYLOR AND CO. BLACK-HORSE-COURT.

1805.

BIBLIOTHECA
REGIA
MONACENSIS

TO

LORD CARRINGTON,

BY WHOSE UNREMITTING EXERTIONS

WHILE

PRESIDENT OF THE BOARD OF AGRICULTURE,

VARIOUS

IMPROVEMENTS IN THE ART OF HUSBANDRY

WERE

EFFECTED AND BROUGHT INTO PRACTICE,

THIS WORK,

WHICH HAD THE HONOUR OF RECEIVING HIS EARLY APPROBATION,

IS, WITH PERMISSION,

INSCRIBED BY

THE AUTHOR.

HENDON,
October 19, 1804.

TO

LORD CARRINGTON,

BY WHOSE LIBERALITY AND EXERTIONS

UNDER

THE PATRONAGE OF THE BOARD OF AGRICULTURE,

VARIOUS

IMPROVEMENTS IN THE ART OF HUSBANDRY

HAVE

BEEN CARRIED INTO EFFECT,

THIS WORK,

WHICH HAD THE HONOUR OF RECEIVING HIS EARLY APPROBATION,

IS, WITH PERMISSION,

INSCRIBED BY

THE AUTHOR.

Hereford,
October 19, 1808.

PREFACE.

In consequence of a more perfect acquaintance with the nature of soils, and with the operation of the various substances that are made use of in the business of cultivation, as well as from additional experiments and more close applications of the principles of other sciences, numerous alterations and improvements have been introduced in the different branches of the art of husbandry, and a great variety of new facts, opinions, and conclusions have been brought to the attention of the agricultor. These improvements have, however, been hitherto of little use, from their being scattered and dispersed through innumerable volumes, without method or arrangement to render their connection, or dependence, clear and intelligible.

It has been the object of the present work not merely to reduce such detached facts into better order, but at the same time to bring the practical details and conclusions into a more intimate connexion with the principles on which

they depend; and in this way afford a more connected and systematic view of the various particulars that interest the cultivators of the ground; whether in the nature of implements, the œconomy and convenience of buildings and roads, or in the raising of different kinds of field crops, the cutting and feeding down meadow and pasture lands, and the management of various sorts of live stock. By such means, it is hoped, the knowledge of the principles of agricultural science may be more readily acquired and extended, and the utility and importance of different practices and discoveries be more fully appreciated and understood.

The undertaking has been attended with considerable difficulty, in many instances, from the insufficiency and incompleteness of experiments and the involved state of the facts, which may afford some apology for the imperfections that may be discovered in the execution; but the author has in all cases endeavoured to rest the processes and methods of management which he has had occasion to recommend, on those practical foundations which in his judgment appeared the most certain and correct. How far he may have succeeded in performing the work in an useful manner, he leaves to the candour of those who are best acquainted with

the difficulties that stand in the way of such an attempt. His pretensions are founded on the experience which he has obtained from having practised the Art on an extensive scale, and from the opportunities which he has had of examining it in different parts of his own and other countries.

In bringing together the widely scattered materials, he has been particularly careful to have recourse to the best and most approved works of the practical kind, of some of which he has had occasion to make considerable use. This has been particularly the case in elucidating the principles and practice of draining land; the methods discovered and recommended by Mr. ELKINGTON, and described with much accuracy and correctness by Mr. JOHNSTONE, having been freely employed, as well as many of the plans which illustrate them. To Mr. BEATSON and Mr. CROCKER he is likewise under similar obligation for various useful observations on the nature of farm buildings and cottages, as well as in the construction of roads. The valuable writings of Mr. YOUNG and Mr. MARSHAL, and those of many others, have afforded him facts and details of the practical kind where his own experience was insufficient or incomplete.

For accurate drawings of the natural British grasses

he is indebted to Mr. SALISBURY, the able successor to Mr. CURTIS at the Botanic Garden, Brompton. For correct drawings of several breeds of cattle and sheep, he is obliged to Mr. GARRARD and Mr. SCOTT. And the different laws and regulations which relate to agriculture have been carefully selected and digested into order, by Mr. THOMAS WALTER WILLIAMS, an able and intelligent barrister.

From the great attention that has been bestowed in correcting and improving the figures in the plates of implements and agricultural machinery, it is hoped they will be found well adapted to the views of the practical farmer, and will bring him more fully acquainted with the improved means of cultivation.

In regard to arrangement, the Author has pursued that which seemed to proceed from the nature of the subject, without any regard to what has been done by others; his great object being to present to the agricultor, in as narrow a compass as possible, a complete and connected system of husbandry.

October 13, 1804.

INTRODUCTION.

AGRICULTURE, though it has probably made a greater progreſs in this than moſt other countries, is ſtill far from having attained that degree of perfection which might have been expected, and of which it is capable :—much remains to be effected in almoſt every branch. If the ſtate of the art be examined with attention, it will be found that though in particular diſtricts and ſituations its principles and operations may have been well underſtood, and the lands of courſe have been conducted under an improved ſtate of cultivation; yet, that on the whole, but a very ſmall portion of the cultivated part of the iſland has even at this advanced period been brought under a judicious and well-conducted ſyſtem of huſbandry. Immenſe tracts of land of the more rich and fertile kinds may ſtill be met with in different parts of the kingdom that are managed in very imperfect and diſadvantageous methods of farming. It has been ſtated by an able writer* that Great Britain contains ſixty-ſeven millions of acres; ſeven millions of which are taken up by houſes, roads, rivers, lakes, &c., conſequently incapable of cultivation ; and that of the remaining ſixty millions, only five millions are employed in raiſing grain, and twenty-five millions in paſturage, while thirty millions are either completely in a ſtate of waſte, or cultivated " under a very defective ſyſtem of huſbandry."

But it is not merely in regard to the cultivation of the ſoil that the advancement of the art has been ſo ſlow and confined; in other departments or branches its progreſs has been equally limited. In the management of meadow and paſture-lands, and the improvement of the breeds of different kinds of domeſtic animals, except in

* Sir John Sinclair.

particular inſtances, there appears to have been a greater degree of neglect or inattention, though it muſt be allowed that regard is as neceſſary to be had to theſe as to that of arable cultivation; the connexion between them being ſo intimate, that however well a farmer may be acquainted with arable practice, unleſs he at the ſame time poſſeſſes the proper knowledge of improving and keeping his graſs lands in order, and of breeding, rearing, and feeding animals, he muſt manage to very conſiderable diſadvantage. Without this knowledge it is impoſſible for him to diſtinguiſh the different breeds of animals, or know that which is the moſt ſuitable and beſt adapted to the nature, ſituation, and circumſtances of his farm, or to feed them in the moſt proper and advantageous methods.

In the inſtrumental part of huſbandry, though much has been lately done, much is ſtill to be accompliſhed before that degree of œconomy, convenience, and utility is attained that the ſubject is capable of admitting, and which the nature of the art requires. It muſt however be allowed that valuable additions of this kind are daily introducing themſelves.

The cauſes that have produced this ſlowneſs in the progreſs of an art which undoubtedly claims the greateſt regard and encouragement are not only numerous but extremely different in their nature. On a near inveſtigation of the ſubject, it will probably be found that agriculture has however been leſs retarded by the incapacity or inattention of thoſe who have been engaged in the practical part of the profeſſion, than by the different regulations and reſtrictions with which it has been fettered, and which have been ſuffered to continue after the circumſtances that gave them birth have been either entirely changed or undergone very material alterations. It is not, however, on this account to be concluded, that the advancement of huſbandry, as a ſcience, has not been impeded by the influence of other cauſes; it has obviouſly been much reſtrained at all times, and eſpecially in the more early periods of its cultivation, by the want of a clear and explicit knowledge of its principles, and of greater preciſion and correctneſs in the language made uſe of in their explanation. It has been obſerved by an able writer that while a want of due preciſion and diſcrimination is ſuffered to exiſt in the definitions and deſcriptions of thoſe ſubſtances which conſtitute the baſis of agricultural knowledge, it is utterly impoſſible that it can be carried to any degree of perfection as a ſcience. It is from this ambiguity and incorrectneſs in the language of the art, that the cul-

tivators of land in one part of the country are frequently incapable of profiting to any extent by the accounts that are given of what has been done by the exertions of thoſe in another. This is ſufficiently ſhown in what has been done in reſpect to the nature of ſoils; agriculturiſts in general having given ſuch deſcriptions and definitions of them as coincided with the notions that they had formed concerning their nature in their own particular diſtricts or ſituations, rather than ſuch as marked their particular properties and compoſitions*. Knowledge of this kind, however juſt or accurate it may be in regard to the ſoil of the places from which ſuch deſcriptions are drawn, muſt, he contends, be very imperfect in reſpect to others, and of courſe be incapable of any general application or utility. For it muſt be obvious to every one who is in the leaſt degree converſant with the buſineſs of cultivation, that ſoils do not only differ very materially in the nature of their principal ingredients, but alſo in the proportions or quantities in which theſe enter into ſuch compoſitions as are denominated ſoils. Thus the mere aſſertion of a ſoil being clayey, loamy, gravelly, &c., conveys little information, as it does not make us in the leaſt acquainted with either the properties or proportions of the ſubſtances from which they are thus denominated. Beſides, it is known to every farmer that there is the greateſt difference in the nature of clays and other ſubſtances which conſtitute the baſis of ſoils as they exiſt in the ſtate of earth or mould; the clayey ſoil of one tract of country being extremely fertile and productive, while that of another poſſeſſes the higheſt degree of ſterility and barrenneſs. There are likewiſe very conſiderable differences in the loamy and gravelly ſoils of different districts, which are by no means diſtinguiſhed by ſuch unqualified terms†. For this reaſon it probably is that experience in farming has had a leſs general effect in improving the ſcience of agriculture than may have been ſuppoſed; and it is perhaps from the ſame cauſe that the principal improvements in the profeſſion have been confined to particular ſituations and diſtricts, from which they have extended themſelves by very ſlow and gradual means.

The difficulty of determining the connexion of effects and their cauſes, and the length of time that is requiſite to fully aſcertain any particular fact or circumſtance in farming are alſo cauſes that have conſiderably impeded the ſcientific progreſs of agriculture. After much labour, time and expenſe have been employed in order to elucidate and aſcertain particular facts of this kind, it not unfrequently

* Anderſon's Recreations in Agriculture, &c. Vol. I. † Ibid

happens that the experimenters are incapable of accompliſhing their objects, or draw ſuch concluſions as can be ſafely depended upon; ſo various and ſo involved are the circumſtances that influence the reſults of experimental attempts in this ſcience. In this way, however, it is remarked, a ſort of experience is begotten and tranſmitted in the art which is difficult to be rejected; but which, if adopted, muſt often inevitably lead to error and diſappointment in the practice of the farmer. Beſides, this, as well as other ſciences, has been greatly embarraſſed and retarded by details of imaginary experiments and diſcoveries, which are very apt to impoſe upon the minds of thoſe who are not very well informed concerning rural affairs*.

There is likewiſe, it is added, in the buſineſs of agriculture much confuſion introduced by the difficulty which even the beſt judges frequently find in making their deciſions, where a number of circumſtances and cauſes are combined, concerning thoſe which are eſſential and neceſſary to particular operations and proceſſes, from ſuch as are merely accidental and of little import. The want of correctneſs too, in regard to the abſolute expenſe incurred in accompliſhing various operations in reſpect to any particular object of huſbandry, and the difficulty in many inſtances of preſerving the products of different trials diſtinct, have had a tendency to impede the advancement of the art; as from ſuch inaccuracy the farmer is frequently incapable of aſcertaining, with any degree of exactneſs, either the ſum which he has expended or the value of the produce which he has obtained; conſequently he cannot be in a ſituation to eſtimate the advantages of ſuch operations or proceſſes, from which the profeſſion remains where it was before the commencement of his attempts. The want of accuracy and preciſion in matters of this kind has alſo led to the introduction of an extremely pernicious ſyſtem of proceeding in different inſtances, which is that of making concluſions by a ſort of gueſs-work. Nothing can however be more fallacious than this mode of deciding; becauſe a perſon under ſuch circumſtances is almoſt certain to be influenced by ſome preconceived opinion reſpecting the particular object of his deciſion†. Facts collected and aſcertained in this way, as they can but ſeldom have any ſolid baſis, muſt of courſe greatly retard the progreſs of agriculture. The concluſions that are drawn by means of experiment are even frequently liable to objection, and hence the improvement of the profeſſion is not ſo much promoted by this method as many perſons may ſuppoſe. In making ſuch experiments as are to elucidate and explain the facts in

* Anderſon's Recreations, Vol. I. † Ibid.

this ſcience which are doubtful or not well underſtood, much knowledge, care, and circumſpection is conſtantly neceſſary on the part of the experimenter, to guard againſt every thing that may in the leaſt degree influence the reſult: for if this point be not careſully attended to, very different concluſions may be drawn from the ſame experiment. The farmer, from his not having been accuſtomed to that accuracy and preciſion which is requiſite in this mode of inquiry, is often but indifferently prepared to avoid errors, which may be produced by a variety of unſuſpected cauſes, which conſiderably influence the reſults of his trials. On this account the inductions that are drawn from the experimental attempts of even real farmers can ſeldom be ſo fully depended upon as may at firſt ſight be ſuppoſed: where due care and attention are beſtowed, this is, however, the beſt and moſt certain means of increaſing our knowledge, and extending the bounds of the art.

The want of a better and more complete knowledge of the different branches of ſcience which are intimately connected with that of agriculture, among practical farmers, has not been leſs prejudicial to the improvement of huſbandry, by the incorrectneſs and inattention which it may have cauſed in the aſcertaining of particular facts and circumſtances in the profeſſion itſelf, than by the prejudice and attachment which it has engendered to particular cuſtoms, practices and methods of management. The minds of thoſe who ought to have been the moſt capable of enlarging the bounds of agricultural knowledge have frequently by this means been fettered, and kept from taking any new or particular views of the various objects and operations of huſbandry. And this is perhaps one of the cauſes of farmers having proceeded ſo much in the ſame track ſince the commencement of the art.

That agriculture is capable of being advanced to a conſiderable ſtate of improvement, by a more correct and general application of ſuch principles and reaſonings as are borrowed from other ſciences with which it is connected, is extremely probable from the ſucceſs and progreſs that has been made by the little that has been already done in this way, as well as from what may have been obſerved to take place in conſequence of ſuch application in other arts.

After this curſory view of the principal cauſes which appear to have impeded the advancement of agriculture as a ſcience, we may proceed to thoſe that operate againſt its extenſion and improvement as a practical art. Impediments of this kind are however ſo exceedingly numerous and complicated, that it is not intended

to enter into any full or elaborate diſcuſſions reſpecting them; but merely to bring them to the notice of the agricultor.

It is eaſy to perceive that a variety of obſtructions muſt have been thrown in the way of agricultural improvement, by thoſe ſlow and imperceptible changes that are continually taking place in the ſituation and circumſtances of a country, by which laws, regulations, and reſtriction that were once proper and uſeful, become in the courſe of time highly detrimental and improper. From this cauſe it is that the early regulations that were made in reſpect to the management of lands in this iſland, are ſo badly adapted for promoting the advantages of huſbandry at the preſent period. This is fully exemplified in the caſe of commons. The ground in ſuch inſtances does not merely lay in the ſtate of waſte, being debarred and deprived of undergoing any cultivation, although frequently very capable of admitting of it, but it is detrimental by preventing improvements in the adjoining lands from being carried on in the moſt complete manner and with the fulleſt effect, as well as by being expoſed to injuries of the moſt baneful kind by the cutting away and removal of its ſurface, the ſinking of pits, the ſtagnation of water, as well as a thouſand other practices, while the nation derives not the ſmalleſt advantage from it in return for ſuch a ſyſtem of deterioration.

But it is not only in this point of view that commons are prejudicial or uſeleſs; they are a kind of property that has much effect in injuring the morals of the poorer claſſes of inhabitants who claim rights on them, by engendering quarrels and diſputes, and relaxing thoſe habits of induſtry, economy and exertion, which are eſſential to the labourer in huſbandry, by holding out to him a fallacious means of ſubſiſtence.

There is alſo a kind of *commonable* property which in ſome counties appears, from the late excellent ſurveys that have been made, to be nearly one half of their whole arable territory; in which each individual knows indeed the limits of the lands that he poſſeſſes, but is under the neceſſity of ſubmitting to certain regulations and reſtrictions that cuſtom has eſtabliſhed, however abſurd or diſadvantageous they may be in the cultivation and management of them. This circumſtance, inſtead of exciting the farmer to induſtry and improvement, tends very materially to leſſen his exertions and introduce ſlovenly modes of practice highly prejudicial to the intereſts of agriculture. Lands conducted under ſuch a ſyſtem of management cannot probably be made to produce one half the quantity of grain or other ſubſtances, which they might be made to do under improved methodsof cultivation.

That great inconvenience and much diſadvantage, in a natural as well as individual point of view, ariſes from the poſſeſſion of lands clogged with ſuch cuſtoms, cannot be doubted; but perhaps the greateſt miſchief is the reſtraint which is thus impoſed on the art of huſbandry.

The tenures of land, in many inſtances, are not leſs injurious to the advancement of agriculture than the circumſtance of grounds being waſte or in a commonable ſtate. A large part of the land of this country is held under lords-of-manors, by a kind of copy-hold or cuſtomary tenure which ſubjects the tenants to the payments of fines on the deceaſe of the lords or tenants, and on the alienation of the property, as well as certain annual rents, and in ſome places even to the performance of various diſagreeable ſervices; from which it is impoſſible that the holders of lands under ſuch reſtricted conditions, eſpecially where the lords are entitled to fines proportioned to the improved value of ſuch property, can be diſpoſed to the expenditure of money, or the uſing of much exertion in order to bring ſuch lands into an improved ſtate of huſbandry. It has been juſtly obſerved that, "one great obſtacle to improvement, ariſes from a laudable anxiety in the cuſtomary tenants to have their little patrimony deſcend to their children. Theſe ſmall properties, loaded with fines, heriots, and boondays, joined to the neceſſary expenſe of bringing up and educating a numerous family, can only be handed down from father to ſon by the utmoſt thrift, hard labour, and penurious living; and every little ſaving being hoarded up for the payment of the *eventful fine*, leaves nothing for the expenſe of travelling to ſee improved modes of culture; to gain a knowledge of the management and profits of different breeds of ſtock; and to be convinced by ocular proofs, that their own ſituations are capable of producing ſimilar advantages: and even ſhould they be half inclined to adopt the new practice, prudence whiſpers, that ſhould the experiment fail, it would require the ſaving of many years to make good the deficiency*."

Such lands too as are held under corporations, whether they be civil or religious, as they do not afford the occupiers of them that kind of intereſt and ſecurity which becomes the ſtimulus of exertion and improvement, are of courſe detrimental to the progreſs of the profeſſion. In lands of this tenure no exchanges for the purpoſe of mutual accommodation and advantage can be entered into; no improvements in the way of cutting canals or laying out roads can be ſafely made without the

* Modern Agriculture, Vol. IV.

intervention of the legiſlature. But what is ſtill more hurtful, leaſes of very ſhort periods can only be granted; from which circumſtance ſuch lands muſt conſtantly remain under very imperfect ſyſtems of management.

The poſſeſſion of lands under deeds of entail may likewiſe be conſidered as prejudicial in the ſame way; as in ſuch caſes no inducement is held out for the expenditure of money, and the conſequent improvement of ſuch property.

But obſtacles of a more general and powerful nature are found in the various indefinite claims that are made on lands. The payment of tythes in kind, from its operating directly as a tax on the capital and productive labour of the farmer and land-proprietor, as well as from its being vexatious in the mode of its collection, is a meaſure that impedes the improvement of the art of huſbandry in a very ſerious degree. In the cultivation of arable farms, eſpecially if the land be in ſuch a condition as to require the expenditure of large ſums of money in the purchaſe of manure, and conſiderable labour and exertion in other reſpects in order to bring it into the ſtate of producing abundant crops, its effects are experienced in the moſt injurious and oppreſſive manner. The efforts of the huſbandman in this caſe have been "compared to thoſe of a labourer, who ſhould make conſiderable exertions during the hours of relaxation throughout the day, in order that he might obtain a bit of ſomething hot for ſupper; and when he was juſt preparing to enjoy his hard-earned morſel, he had it taken away from him by a neighbour, who ſtood by idle all day, and now came, by means of a legal authority he had obtained as a reward for ſome exertions of his predeceſſors, when the ſtate of ſociety rendered ſuch a mode of remuneration the eaſieſt of any that could then be deviſed, to ſeize that which the poor man gained by the ſweat of his brow. Though the poor man is forced to give up his morſel in this caſe, it is impoſſible for him to yield it without reluctance, or ever after to view his neighbour with a favourable eye. It provokes an inviduous parallel to be drawn between the two parties, which eſtranges them the more from each other. The conſequence is, that although, in this particular circumſtance, the one gains juſt as much as the other loſes; yet it tends very little on the whole to the emolument of the receiver; becauſe the looſer ſays within himſelf, ſince I cannot enjoy my own morſel myſelf, I can at leaſt prevent my neighbour from getting it, for nobody can compel me to earn it but if I pleaſe. So down he ſits in indolence; and neither of them enjoys the bleſſing that might have reſulted from induſtry*."

* Anderſon's Eſſays, Vol. III.

The ſpirited cultivator may be inclined to improve his lands, as is frequently the caſe, even where the profit he is to derive from ſuch improvement cannot be conſiderable; but under ſuch circumſtances he muſt conſtantly be prevented from proceeding by the operation of this injudicious regulation: where a tenth or more of the produce ariſing from the exertions of the improver are to be taken away, it is obvious that ſmall returns will not anſwer; eſpecially in a buſineſs where there is much riſk from ſeaſon and other cauſes. By this means the community is conſequently deprived of the various advantages reſulting from increaſed induſtry and augmentation of produce. By the ſame ſyſtem alſo, much good land, excluſive of commons and waſtes is conſtrained to remain in the unprofitable ſtate of graſs, which might otherwiſe, by a trifling expenditure of money, and no very extraordinary degree of exertion, be rendered greatly more productive under proper arable management. And it is likewiſe highly injurious in many inſtances, by ſubjecting the farmer to a diſguſting dependence on the tythe-owner.

It is evident that the effects of this meaſure muſt be equally detrimental to the intereſts of the proprietors of lands as to thoſe of actual farmers; for whatever tends to leſſen the exertion and induſtry of the latter muſt neceſſarily diminiſh the incomes of the former, and in a proportion much greater than is commonly ſuppoſed. But they are injured in another way beſides that of rent; for as a tenth of the produce of the lands is thus taken away in kind, a deficiency of manure to that extent muſt be the conſequence, the diſadvantages of which are now generally well underſtood. The effect which the abolition of tythes in Scotland has had in promoting agricultural improvements, alſo affords a ſtrong and ſatisfactory proof of their operating powerfully againſt the advancement of huſbandry; for it cannot be attributed to any other circumſtance that improvements have been carried on ſo much more extenſively in that part of the iſland than in this.

But it is not merely in ſtopping the progreſs of agricultural improvements that the payment of tythes in kind is prejudicial, its effects are injurious in many other points of view which it is unneceſſary to conſider at preſent. It is therefore a matter of the utmoſt importance that ſuch an alteration or modification ſhould be effected as might render the claims of the proprietors ſecure, without producing thoſe miſchievous conſequences which proceed from it in its preſent form*.

* An able and ingenious cultivator, the Rev. H. J. Cloſe, has ſuggeſted a plan for the removal of the payment of tythes in this way, which, from its nature and ſimplicity, ſeems to deſerve our attention. The Communications to the Board of Agriculture, Vol. III.

The preſent method of providing for the poor, notwithſtanding the judgment and deliberation with which it was adopted, is unqueſtionably detrimental to the advancement of agriculture, as well as greatly prejudicial to morals and induſtry, from its falling diſproportionately heavy on land-holders of every deſcription, nearly three-fourths of the whole amount of the immenſe ſum being raiſed by that claſs of ſociety. The proprietors of land, are however, in ſome meaſure enabled to throw this burthen from themſelves by ſtipulating with their tenants for the payment of all parochial taxes, ſo that in fact the farmer becomes the principal ſufferer, eſpecially in caſes where any augmentation of the aſſeſſment is required, which is frequently the caſe from the operation of either local or general circumſtances; ſuch as the failure of manufactures or the carrying on of wars*. By theſe means the capital of the farmer is diverted from its proper application, that of being employed in the cultivation and improvement of land, by which the progreſs of huſbandry is not merely impeded, but the community ſuſtains an incalculable loſs.

There are ſtill other obſtacles which retard the improvement of the art beſides thoſe that have been noticed; but they are in general leſs prejudicial in their tendency, or more limited in their operations. Of this kind are the game, the corn, and the ſalt laws; all of which in their preſent forms throw great impediment in the way of agriculture. And the want of proper and convenient markets in many ſituations, for the diſpoſal of different kinds of produce, and of eaſy and expeditious modes of conveying them to ſuch places, as well as a variety of local cuſtoms and regulations, are not leſs injurious in their effects, though much leſs attended to.

Theſe are ſome of the principal difficulties and impediments that have been ſo long ſuffered to retard the progreſs of cultivation, and which muſt continue to put an inſuperable bar to its improvement, in many reſpects, until they are removed.

But the advancement of agriculture has not been ſolely obſtructed by cauſes of this nature; there are many others which the proprietors of lands have the means of obviating. The want of proper and judicious leaſes has at all times operated unfavourably for the improvement of huſbandry, and is an evil very generally complained of by farmers, a circumſtance which is not in the leaſt to be wondered at, as it can hardly be ſuppoſed that improvements will be carried on to any extent

* Modern Agriculture, Vol. IV.

where there is a want of permanent ſecurity for the enjoyment of thoſe advantages that may be derived from them.

It has been juſtly remarked by Mr. Donaldſon, that "that man would certainly be juſtly ſubjected to the reproach of being raſh and inconſiderate in his conduct, who ſhould expend money and labour on the improvement of any farm, where his certainty of continuance does not entitle him to look forward with a confident aſſurance to the period when his exertions are to be rewarded. It is a well-known fact, that the hope of reward ſweetens labour; take that away, and the ſpur to labour ceaſes. It is that alone that calls forth induſtry, and is the ſpring of all exertion. What object then can a farmer have to hazard his capital, and devote the moſt vigorous and active part of his life to the improvement of a farm which he holds on no more certain tenure than the will, or, in other words, than the whim or caprice of his landlord? In every ſuch ſituation, the prudent farmer muſt be reſtrained from any ſpirited expenditure, however much he may be ſatisfied that the improvements, which might thereby be effected, would, under other circumſtances, prove beneficial to the public, the landlord, and himſelf. Have not inſtances occurred, where tenants ſo circumſtanced have been obliged *repeatedly* to agree to pay advances of rent rather than remove; while, from the uncertainty of the tenure on which they held their farms, they were debarred from making thoſe exertions which an advance of rent demanded, and which almoſt uniformly takes place in ſuch caſes when leaſes are granted?"

From an examination of the excellent ſurveys that have lately been made of the agricultural ſtate of the kingdom under the direction of the Board, it appears that by far the greateſt part of the land in many counties is held by tenants merely at the will of their landlords, who of courſe may deprive them of their farms, on proper notice being given, whenever they pleaſe; and in caſes where leaſes are granted they do not extend further than from five to nine years, except in a very few inſtances indeed, in which they may be protracted to the period of nineteen or even twenty-one. And even ſuch leaſes as thoſe are for the moſt part clogged with ſuch reſtrictive clauſes and conditions as put a ſtop to improvement, and confine the cultivator in methods of management that are frequently far from being the moſt advantageous*.

In the firſt caſe, indeed, the farmer is kept in ſuch a ſtate of dependence as is not only highly degrading, but muſt effectually damp and repreſs his exertion and induſtry. And the tenants under ſhort leaſes are not in ſituations much more deſirable, as they cannot with ſafety or propriety enter into any extenſive beneficial

* Modern Agriculture, Vol. IV.

methods of augmenting the produce of their farms, leſt the advantages ſhould be reaped by others. Even a leaſe of twenty-one years, in many ſituations and under different circumſtances, is not ſufficient to allow the farmer to undertake improvements of conſiderable magnitude, as he can neither conduct them in the moſt economical way, nor reap the full advantage of them. Beſides, where money to any great amount is expended in the beginning of ſuch a term, the farmer is often, in order to indemnify himſelf, where he has not a proſpect of remaining, induced to run out and exhauſt the land at the latter end of his leaſe; which is a practice of the moſt prejudicial tendency to the proprietors of ſuch farms, and the community as well as the intereſts of agriculture.

It is evident, therefore, that the farmers of land ſhould in *all* caſes have ſuch a ſecurity for the poſſeſſion of it as will enable them to introduce the moſt improved modes of management, and excite them to adopt the beſt means of improvement. The length of leaſe that may be moſt ſuitable and beſt adapted for theſe important purpoſes is not eaſily aſcertained; it ought probably to vary according to the particular circumſtances and the nature of the improvements that are to be carried into execution*. In ſuch leaſes many clauſes muſt of courſe be requiſite: but they ſhould be ſuch as are plain and ſimple, and ſuch as may not too greatly deſtroy the independence of the farmer, but leave him much at liberty to follow his own plans of cultivation; while they afford effectual ſecurity to the proprietors, by cautiouſly guarding againſt the introduction of ſuch ſyſtems of huſbandry as would be injurious or improper†.

There are many other cauſes of this kind that operate unfavourably for the extenſion of agricultural improvements; but as they are either confined to particular circumſtances, or only poſſeſs a local influence, it is not neceſſary to conſider them with a view to the preſent object.

From what has been obſerved, it is evident that different circumſtances muſt be attended to, in order to bring the ſtate of agriculture to that degree of perfection which its utility demands. It will not only be neceſſary that the principles of the art be rendered more clear and eaſily acceſſible to the cultivator, but that the various proceſſes

* Mr. Donaldſon, after making a variety of uſeful obſervations on the advantage of leaſes, and the length of time that may have the moſt beneficial effects in promoting improvements, concludes, that "that duration of leaſe which entitles the tenant to commence his improvements with ſpirit, and is not of ſuch a length as to induce him, from any fortuitous circumſtances that may take place, as a riſe in the nominal price of produce, or a fall in the value of money, to ſlacken his attention, may be conſidered upon the whole as beſt; and probably twenty years is as equitable a term as in the preſent ſtate of Britiſh agriculture can well be fixed upon."

† See Section on Leaſes, in Appendix.

and practices be brought into a more obvious and intimate connection with them, and more full and complete explanations of the nature and conſtituent properties of the different ſubſtances or bodies that enter into and form the baſis of the profeſſion, afforded; as well as the different clogs and impediments, which have been interpoſed at different times, in the way of regulations, obviated and removed. The author has endeavoured as much as poſſible to furniſh the farmer with a more correct knowledge of the qualities and methods of operation of thoſe materials or ſubſtances with which he is to accompliſh his various purpoſes, as well as the changes which they undergo by an intimate combination with each other; and the modes in which they may be applied and made uſe of with the greateſt chance of ſucceſs and advantage.

The former of theſe have been objects of much conſideration in the preſent work. It has alſo been his wiſh to extend the bounds of his information in reſpect to the means of cultivating the different plants which conſtitute the food of man, or which ſerve for the purpoſe of feeding cattle and other domeſtic animals. In this intention, the various improvements that have been effected in the nature of tillage, and the interpoſition of different ſorts of green crops with thoſe of the grain kind, as well as in the implements and machinery by which they may be performed with the greateſt economy and convenience, have been brought to his notice in as clear and conciſe a manner as the nature of the ſubjects admitted.

And as the various products of the earth can only afford a trifling advantage to the cultivator, unleſs he be perfectly acquainted with the means of applying them as the food of animals, the methods of management that appear the moſt beneficial in the breeding, rearing, feeding, and fattening different ſorts of live ſtock, have, it is hoped, been more fully explained, and placed in more clear and diſtinct points of view.

In regard to the latter, or the removal of thoſe obſtacles which have been thrown in the way of agriculture under the idea of regulating its operations, however neceſſary it may be to the complete improvement of the art, it can only be effected by the interpoſition of the legiſlature and the proprietors of land.

CONTENTS.

SECTION I.

IMPLEMENTS OF HUSBANDRY.

PAGE.

IMPLEMENTS employed in the practice of husbandry . . . 2
Circumstances to be attended to in the construction of them . . . 3
PLOUGHS 4
Different kinds necessary for different soils and situations . . . *ibid.*
SWING-PLOUGHS . . . 5
Variety of . . . *ibid.*
Capable of extensive application . *ibid.*
Peculiarities in their construction . *ibid.*
The advantages of which . . *ibid.*
The Rotheram plough . . . *ibid.*
Small's chain-plough . . . *ibid.*
Ploughs suitable for light friable soils . *ibid.*
Expence of them . . . *ibid.*
Dutch plough . . . . *ibid.*
Suffolk iron swing-plough . . 6
Advantages of, on strong cohesive land *ibid.*
WHEEL-PLOUGHS . . . *ibid.*
Construction various, according to soil, &c. *ibid.*
Less skill in the ploughman necessary for them *ibid.*
Reason of wheels being added to ploughs *ibid.*
Uses of them . . . *ibid.*
Friction of them causes resistance . *ibid.*
Mr. *Middleton*'s opinion of them . . 7
Objections to them . . *ibid.*
Should seldom be employed by good ploughmen . . . *ibid.*
Sorts of soil most proper for . . *ibid.*
Hertfordshire wheel-plough . . *ibid.*
Kentish turnwrist-plough . . *ibid.*
Norfolk wheel-plough . . . *ibid.*
Improved common wheel-plough . . 8
Two-wheel plough . . . *ibid.*
Wheel-plough of the fen districts . . *ibid.*
Double or two-furrows plough . . *ibid.*
Skim-coulter ploughs . . . 11
Trench plough . . . *ibid.*
Uses and advantages of . . *ibid.*

PAGE.

The miner (see p. 322) . . . 12
Its construction and use . . . *ibid.*
Paring plough . . . . *ibid.*
Double-mould-board plough . . 13
Common draining plough . . . *ibid.*
Mole plough . . . . *ibid.*
Draining-furrow plough . . . *ibid.*
Marking plough . . . . *ibid.*
Single-hoe plough . . . *ibid.*
DRILL-MACHINES . . . 14
Construction of them various . . *ibid.*
Principles on which they should be made *ibid.*
Circumstances to be regarded in choosing them *ibid.*
Mr. *Amos*'s drill . . . 16
Mr. *Cook*'s drill . . . *ibid.*
Mr. *Ducket*'s method more simple . . 17
Mr. *Wellard*'s drill . . . *ibid.*
Advantages and uses of . . *ibid.*
Expence of . . . . *ibid.*
Mr. *Bayley*'s TURNIP-DRILL . . *ibid.*
Its uses on one-bout ridges . . *ibid.*
Construction of . . . *ibid.*
His drill for all sorts of grain . . 18
Construction of it . . . *ibid.*
Mr. *Bailey*'s bean-drill for wide intervals *ibid.*
Its form and make . . . 19
Drill barrow . . . . *ibid.*
Uses of . . . . *ibid.*
HOES . . . . *ibid.*
Difference of . . . *ibid.*
Cook's improved horse-hoe . *ibid.*
Amos's expanding horse-hoe more advantageous . . . *ibid.*
On what soils most useful . . . *ibid.*
M'Dougal's hoe . . . *ibid.*
Purpose to which it may be applied . *ibid.*
Improvement in the wheel of . . *ibid.*
Mr. *Ducket*'s hoes . . . 20
Hoeing may be well done by the common plough . . . *ibid.*

CONTENTS.

	PAGE.
Experienced Farmer, his opinion of the use of the plough in this way	20
SCARIFIERS AND SCUFFLERS	21
More generally employed of late	*ibid.*
Method of employing them	*ibid.*
Purposes to which they are adapted	*ibid.*
Construction of them	*ibid.*
Mr. *Cook*'s, &c.	*ibid.*
Experienced Farmer's remarks on them	22
The instrument he uses described	*ibid.*
Objections to which these instruments are liable	*ibid.*
How remedied in some districts	*ibid.*
The extirpator	*ibid.*
Uses and construction of	*ibid.*
Utility of, to be shewn by future trials	*ibid.*
These instruments not in common so effectual as the plough	23
Mr. *Cook*'s cultivator; its construction	*ibid.*
Uses of scarifiers and scufflers in general	*ibid.*
DRAGS	*ibid.*
General construction of	*ibid.*
Uses of	*ibid.*
Common drag	*ibid.*
Duck-footeddrag, in some cases more useful	*ibid.*
Way in which the teeth should be put in	*ibid.*
HARROWS	*ibid.*
Little improvement of	24
To be adapted to particular uses and the nature of the soils	*ibid.*
Kind of teeth most proper	*ibid.*
Inconveniences of harrows in general	*ibid.*
How remedied	*ibid.*
Harrows with running bulls	*ibid.*
Construction of harrows	25
Brake-harrow; double-harrow; and common improved harrow	*ibid.*
Mr. *Graburn*'s harrow; uses of	*ibid.*
Mr. *Knight*'s harrow; advantages of	*ibid.*
Harrows proper for grass seeds	26
Bush-harrow	*ibid.*
Mode of harrowing	*ibid.*
ROLLERS	*ibid.*
Construction and proper size of	*ibid.*
Common rollers	27
SPIKE ROLLER	*ibid.*
DRILL ROLLER	*ibid.*
THRASHING MACHINES	28
Principles of	28
Improvements of	*ibid.*
Objections to	*ibid.*
How obviated	*ibid.*
Circumstances on which their good thrashing depends	*ibid.*
Circumstances to be attended to in using them	30
Additions that may be made to them	31
Mr. *Middleton*'s opinion on the use of them	*ibid.*
Their advantages over the flail	*ibid.*
WINNOWING MACHINES	*ibid.*
Different kinds of	*ibid.*
Cor's and *Rodgers*'s on good plans	32
CHAFF CUTTERS	*ibid.*
Different constructions of	*ibid.*
In general too expensive	*ibid.*
Cook's and *Nailor*'s	*ibid.*
Improvement in one made by the successors of *Winlow*	*ibid.*
RAKES	*ibid.*
Spring-teeth-rakes	*ibid.*
Corn-rakes	33
Twitch-rakes	*ibid.*
Mode of constructing them	*ibid.*
Horse and stubble-rake	*ibid.*
WHEEL CARRIAGES	*ibid.*
Circumstances to be attended to in their construction	*ibid.*
Faulty construction of the Berkshire	*ibid.*
Improvement of, suggested	*ibid.*
Waggons for husbandry	34
In general disadvantageous for the purposes of the farmer	*ibid.*
Irish car	*ibid.*
Construction, uses, and advantages of	*ibid.*
CARTS	35
SINGLE-HORSE-CARTS most useful	36
Close or coup-cart, description of	*ibid.*
General construction of	*ibid.*
Observations on the advantages of one-horse carts	*ibid.*
Corn and hay carts	38
Welsh cart	*ibid.*
Quarry-cart	*ibid.*
Drag-cart	*ibid.*
Remarks on carts in general	39

CONTENTS

SECTION II.

FARM-HOUSES AND OFFICES.

PAGE.

FARM BUILDINGS . . . 43
Too little attention in the construction of *ibid.*
Facility and dispatch of business connected with form and arrangement of . . 44
Commodious distribution of, necessary . *ibid.*
When not the case, much time lost in the conveyance of materials . *ibid.*
Size of, proportioned to that of the farm . *ibid.*
When of the grazing kind few buildings necessary . . . *ibid.*
These chiefly of the cheap shed kind . *ibid.*
Permanent roofs mostly advantageous . *ibid.*
Expence saved by walls with occasional coverings . . . *ibid.*
This plan only recommended in particular cases . . . *ibid.*
Different sorts of sheds necessary for different kinds of cattle . . *ibid.*
Cool ones for store cattle . . *ibid.*
Warm ones for feeding stock . . *ibid.*
Different accommodations necessary for dairy farms . . . *ibid.*
Cow-houses large . . . *ibid.*
Conveniences for the various operations of the dairy . . . *ibid.*
For corn farms, buildings more numerous . *ibid.*
Calculated to suit different purposes . *ibid.*
Stables sufficiently large . . . 45
Cow and feeding houses adapted to number and kind of cattle . . *ibid.*
Barn and granary sufficiently large . *ibid.*
Where thrashing-machines are erected need not be so extensive . . *ibid.*
Conveniences for young animals of different sorts: horses; cattle; hogs; poultry . . . *ibid.*
FARM-HOUSES . . . *ibid.*
Dimensions of, regulated by size of farm . *ibid.*
Should be airy and commodious . . *ibid.*
Ground-floor plan . . . *ibid.*
Parlour; kitchen; back kitchen; closets for various articles; dairy; pantry; cellar . . . *ibid.*
Divided above into lodging rooms . . *ibid.*
These large, for the sake of ventilation *ibid.*
Windows more outwards in the walls advantageous . . . *ibid.*
Floors of, raised a foot or more . . *ibid.*
Hip-roofs preferable to gable-ends . *ibid.*
Thickness of walls according to materials . 46

PAGE.

When thin, easily penetrated by the sun or cold 46
Should be of good thickness . . *ibid.*
Principal objects in, convenience and cheapness . . . *ibid.*
BARNS . . . . *ibid.*
Size and construction of, various . . *ibid.*
Where thrashing-machines and stacking are in use, large ones unnecessary . *ibid.*
Dimensions larger where the flail, and housing grain, are practised . *ibid.*
Slides necessary for the admission of air . *ibid.*
Construction of floors . . . *ibid.*
Best of oak plank 47
Clay and other similar kinds of floors liable to crack and break up . *ibid.*
When formed of plank, should be ploughed and tongued, and have a foundation of brick-work . *ibid.*
More secure and freer from damps than when nailed to sleepers . *ibid.*
Floors of brick nearly equal . . *ibid.*
Thrashing floor . . . *ibid.*
Twelve by eighteen feet a good size . *ibid.*
Addition of flues or drying-floors useful . *ibid.*
Cow-houses, or other offices, may frequently be provided on the ground-floors . *ibid.*
This method has various advantages . *ibid.*
Less expensive; saves room; grain more secure . . *ibid.*
Chamber barn floors: easier to thrash upon *ibid.*
Pitching-holes useful in every form of barn *ibid.*
Unloading in the barn more expeditious by them . . *ibid.*
GRANARIES . . . *ibid.*
Should be firmly built . . . *ibid.*
Have extensive flooring . . . 48
Contrived to avoid labour . . *ibd.*
Effected by particular construction of floors . . . *ibid.*
Free ventilation by latticed windows . *ibid.*
Spouts or ventilators on the top . . *ibid.*
A square the best form . . . *ibid*
Should be built on short posts or pillars of stone . . . *ibid.*
Lined with boards closely joined together *ibid.*
Outside covered with weather-boarding . *ibid.*
In common granaries, attention not necessary to all these points . . *ibid.*
Need not be so strongly nor expensively built *ibid.*

CONTENTS.

PAGE.

Most proper situation in the barn, where housing grain is not practised . 48
Machinery for raising the corn necessary . *ibid.*
STABLES 49
Elegance not requisite in . . *ibid.*
Comfortable and convenient ones necessary *ibid.*
Should be so contrived as to preserve nearly an equality of temperature at different seasons . . *ibid.*
Must be provided with proper drains for the removal of moisture . . *ibid.*
Moveable shutters, as windows, save expence . . . . *ibid.*
Racks and mangers . . . . *ibid.*
Economy and convenience in construction of . . . *ibid.*
Large ones disadvantageous . . *ibid.*
Should have a more perpendicular position than usual . . *ibid.*
Placed conveniently in niches in walls . 50
Conveniences at bottom of to collect hay-seeds useful . . *ibid.*
Hatches save time in feeding . . *ibid.*
Mangers need not be the width of stalls . *ibid.*
Small boxes convenient for . . *ibid.*
Cheap method of forming stalls and racks *ibid.*
Sparred at bottom to admit hay-seeds . *ibid.*
Box under for that purpose necessary *ibid.*
Single stalls better than double . . *ibid.*
Attention necessary in paving stables . . 51
Should approach to a level . . *ibid.*
Moisture removed by small middle-drain *ibid.*
All the drains to empty into a large one *ibid.*
Stall drains covered by perforated oak planks . . . *ibid.*
Main drains placed at ends or bottoms of stalls . . . *ibid.*
Shallow open drains less expensive . *ibid.*
Pavement of stalls should have very slight inclination to drains . . *ibid.*
Advantages gained by this construction of stalls . . . *ibid.*
Size of stalls 52
Five feet a good one : . . *ibid.*
Divisions of should be high . . *ibid.*
For stallions and young horses, sparred to the top . . . *ibid.*
Or divided by doors hung to back posts of stables . . *ibid.*
Latter method useful for mares and foals *ibid.*
Harness place near the stable necessary . *ibid.*
Situation for corn bin . . . *ibid.*
When placed above should feed by a spout in the stable . . *ibid.*
This mode has advantages . . *ibid.*
COW HOUSES AND FEEDING HOUSES *ibid.*
Nearly similar . . . . *ibid.*
Calf-pens in them sometimes . . *ibid.*

PAGE.

Plan not to be adopted . . 52
Better at a small distance . . *ibid.*
May be contrived to suit either purpose . *ibid.*
In the form of single or double sheds . *ibid.*
Must be capable of free ventilation . *ibid.*
Require little labour in cleaning . *ibid.*
Have drains to keep the cattle dry . *ibid.*
Free circulation of air necessary in . *ibid.*
Without it cattle liable to disease . . 53
Sheds open behind sometimes useful . . *ibid.*
Air-holes in roofs occasionally necessary . *ibid.*
Windows in gable-ends frequently useful . *ibid.*
Advantages of such means . . *ibid.*
Feeding of animals promoted in this way, &c. . . . *ibid.*
Modes of construction . . . *ibid.*
Circumstances to be attended to in . *ibid.*
Common method injudicious . . *ibid.*
Feeding from holes without . . 54
Objections to . . . *ibid.*
Most convenient plan of, in single sheds *ibid.*
Double ones more economical and useful *ibid.*
Less extent of building necessary in *ibid.*
Less destruction of fodder . . *ibid.*
Room over useful in all sheds . . *ibid.*
Double sheds not supposed so advantageous *ibid.*
An intelligent feeder's opinion on . *ibid.*
Rooms over prejudicial . . *ibid.*
Plan recommended by him . . *ibid.*
Room in the middle of, necessary . *ibid.*
Keeping cattle clean and dry, uses of . *ibid.*
Contrivances for lessening labour essential 55
Means of doing which . . *ibid.*
Attention to paving stalls necessary . *ibid.*
This frequently not done . . *ibid.*
Double stalls useful . . . *ibid.*
The expence of, greater . . *ibid.*
In many cases unnecessary . . *ibid.*
Conveniences for food and water necessary *ibid.*
Drains and reservoirs should constantly be formed . . . *ibid.*
CALF PENS . . . *ibid.*
Situation of . . . . *ibid.*
Near cow-house . . . 56
Mode of laying floors of . . . *ibid.*
Disagreeable effluvia thus avoided . . *ibid.*
Moveable divisions in, useful . . *ibid.*
Troughs and racks sometimes necessary . *ibid.*
Food more equally distributed by them *ibid.*
In general not requisite . . . *ibid.*
DAIRIES . . . *ibid.*
Advantages of good ones . . . *ibid.*
Are of different kinds . . . *ibid.*
Construction of each . . . *ibid.*
Proper situation of . . . 57
Most advantageous covering of . . *ibid.*
Thatch useful for . . . *ibid.*
Stone walls always preferable . . *ibid.*

CONTENTS.

PAGE.

Proper height of cielings of . . 57
High windows necessary . . *ibid.*
Should have frames with gauze stretched on them . . . *ibid.*
Utility of . . . . *ibid.*
Floors of . . . . *ibid.*
Best materials for . . . *ibid.*
Proper manner to be laid . . *ibid.*
Well near, necessary . . . *ibid.*
Mode of filling up . . . *ibid.*
Vessels for 58
Different materials . . *ibid.*
Lead . . . . *ibid.*
Marble . . . . *ibid.*
Slate ones made by Mr. *Hind*, at Swithland, near Leicester . . *ibid.*
First must be kept clean . . *ibid.*
Plugs and cocks necessary for coolers *ibid.*
Large cock for water requisite . . *ibid.*
Flues for conducting heat sometimes necessary in them . . . *ibid.*
Circumstances to be attended to in cielings and walls . . . *ibid.*
Churning-room near the milk-house . *ibid.*
Fire-place necessary where utensils are kept *ibid.*
Stone slabs on strips of wood necessary on outside of . . . *ibid.*
Smoking of chimnies in, prejudicial . *ibid.*
CHEESE DAIRY . . . *ibid.*
Milk-house for, nearly similar with the other . . . *ibid.*
Here too sometimes useful to have milk-shelves . . . 59
Pressing or scalding house on same plan as for churning . . . *ibid.*
Should always have a good press in salting-room . . . *ibid.*
Should be laid with flags . . *ibid.*
Strong table and shelf necessary . . *ibid.*
Cheese room . . . . *ibid.*
Best over the dairy . . . *ibid.*
Commonly above cow-house or kitchen . *ibid.*
Reasons of . . . . *ibid.*
SHEDS . . . . *ibid.*
Highly convenient . . . *ibid.*
Modes of constructing them . . *ibid.*
Useful for various purposes . . *ibid.*
STRAW-HOUSES . . . 60
Frequently useful . . . *ibid.*
Save straw and time . . . *ibid.*
Prevent litter . . . *ibid.*
ROOT-HOUSES . . . *ibid.*
Necessary to the supply of winter food . *ibid.*
Roots or other vegetables . . . *ibid.*
POULTRY HOUSES . . . *ibid.*
Circumstances in construction of . . *ibid.*
HOG-STIES . . . 61
Mode of constructing them . . *ibid.*

PAGE.

Troughs contrived to prevent waste of food . 61
Boilers for preparing food sometimes requisite in . . . *ibid.*
COAL AND WOOD-HOUSES . . 62
Most useful construction of . . *ibid.*
WORK-SHOPS . . . *ibid.*
Utility of . . . . *ibid.*
TOOL-HOUSES . . . *ibid.*
Circumstances to be attended to in . . *ibid.*
STORE-ROOMS . . . 63
Situation for . . . *ibid.*
Various uses of . . . *ibid.*
FARM SERVANTS' ROOMS . . *ibid.*
Necessary on large farms . . *ibid.*
Advantages of . . . *ibid.*
Best situation for . . . *ibid.*
Ground-floors of stone or brick . . *ibid.*
Upper ones of plaster or brick . . *ibid.*
Mode of forming them . . 64
Arrangement of beds . . *ibid.*
Free circulation of air in, necessary . *ibid.*
PIGEON-HOUSES . . . 65
Should be large and roomy . . *ibid.*
Best situation of . . . *ibid.*
Form of, not material . . . *ibid.*
Sort of covering necessary for . . *ibid.*
Should be secure against vermin . . *ibid.*
Construction of when built separately . *ibid.*
May have sheds under them . . *ibid.*
Objections to wood-coals . . *ibid.*
Entrances of should face the south . *ibid.*
Large holes improper . . . *ibid.*
Weather-boards above them necessary . *ibid.*
Best method of forming the nests . . *ibid.*
Advantages of . . . 667
CONVENIENCES FOR PREPARING CATTLE-FOOD . . . *ibid.*
Advantages of in feeding animals . . *ibid.*
STEAM-BOILERS . . . *ibid.*
Useful in various ways . . . *ibid.*
Description of . . . *ibid.*
Other contrivances proposed . . *ibid.*
Useful for other purposes . . 67
CORN-CHESTS . . . *ibid.*
Necessary and economical . . *ibid.*
Small tub sometimes sufficient . . *ibid.*
That of the granary useful on large farms *ibid.*
Best construction of . . . *ibid.*
CORN-STANDS . . . *ibid.*
Construction of, various . . . *ibid.*
Best mode of . . . *ibid.*
Form of the duke of Bedford's at Woburn Abbey . . . . *ibid.*
Peculiar circumstances in the formation of 68
Materials most proper for . . *ibid.*
Slates or flags sometimes used for bottoms of *ibid.*
Not necessary when the foundation is well laid . . . *ibid.*

	PAGE.
This kind of stand used by Mr. *Bakewell*	68
BEE-STANDS	*ibid.*
FARM-HOUSES AND OFFICES	69
SITUATION AND ARRANGEMENT OF	*ibid.*
MOST ECONOMICAL IN SAVING LABOUR	*ibid.*
Proper situation of	*ibid.*
Near the centre of farm	*ibid.*
A square the most proper	*ibid.*
Offices erected on exposed sides of	*ibid.*
Not attended to in building farm-houses	*ibid.*
These should be at a distance from offices	69
Sometimes such as to overlook the operations going on	*ibid.*
Must be adapted to the business	70
Nature of ground frequently points out situations	*ibid.*
General observations on the expence of farm buildings.	*ibid.*
Estimates of	71

SECTION III.

FARM-COTTAGES.

	PAGE.
COTTAGES	77
Building of, important to agriculture	*ibid.*
Promotes the interest of the farmer and land proprietor	*ibid.*
Advantages of, as explained by different writers	*ibid.*
The assistance of cottagers necessary to the farmer	*ibid.*
The utility of connecting such buildings with farms	*ibid.*
Useful in other points of view	*ibid.*
Most expert labourers in husbandry produced by this means	*ibid.*
Without them much time frequently lost	78
Farmers often injured	*ibid.*
Advantageous to have many on arms	*ibid.*
May sometimes be beneficial for tenants to build, or assist in building them	*ibid.*
Condition of labourers thus much benefited	*ibid.*
Their habits rendered more regular	*ibid.*
More disposed to perform the business of cultivation	*ibid.*
Necessary to remove all obstacles to the erection of	*ibid.*
They promote population	*ibid.*
Useful for the farmer to be more intimately connected with cottagers	*ibid.*
Proper regulations should exist between them	79
Advantages of such a mode	*ibid.*
Should have portions of land annexed to them	*ibid.*
How it may be effected	*ibid.*
Different situation of labourers considered	*ibid.*
Earl of Winchelsea's observations on them	*ibid.*
Difference of cottagers that have land and those that have not	81
Necessity of improving their cottages, shewn	*ibid.*
Certain regulations necessary where land is annexed to them	82
Should be held in the possession of the proprietors	*ibid.*
When held by the farmer injurious to the cottager	*ibid.*
Construction of different, according to circumstances and purposes	*ibid.*
For the farming labourer, plainness, simplicity, and convenience, only necessary	*ibid.*
The miserable hovels they sometimes inhabit, highly disgusting	*ibid.*
Situation of, little attended to	83
Should be rather elevated, not high	*ibid.*
Should be near the farm	*ibid.*
Circumstances to be attended to in the ground-floors of	*ibid.*
In other parts of	*ibid.*
Size of various	*ibid.*
Modes of dividing the rooms in different instances	*ibid.*
Economical modes of placing the stairs	*ibid.*
Mr. *Kent*'s opinion of their accommodations	84
Best forms of	*ibid.*
Circular plan objectionable	*ibid.*
Building two or more together saves expence	*ibid.*
Upper rooms necessary for the preservation of health	*ibid.*
Attention to warmth, &c. necessary in construction of	*ibid.*
Conveniences for free circulation of air, useful	*ibid.*
Means of preventing excessive heat in summer	85
Cheap methods of covering them	*ibid.*
Thatch	*ibid.*
Reed	*ibid.*
Stubble	*ibid.*

CONTENTS.

PAGE.

Pitched paper, mentioned by Mr. *Beatson* . 85
Circumstance to be regarded in materials for building with . . ibid.
Should always be white-washed in the cases here mentioned . . 86
Methods of proceeding where earthy substances are employed . . ibid.
Manner of laying the floors . . ibid.
Materials proper for . . . ibid.
Reasons why plaster is useful . . ibid.
Saving of fuel to be attended to in construction of . . . 87
Means of accomplishing . . ibid.
Builders should attend more to philosophical principles . . . 87
Particulars to be regarded in respect to water in . . . ibid.
Mr. *Holland*'s opinion of . . 88
Various advantages of sheds and privies in ibid.
Expences of, vary according to circumstances . . . ibid.
Different estimates of . . ibid.
Of double brick cottages . 89, 93
Of ditto stud and mud ones . 91, 94
Particulars in the management of . . 96
Different observations on . . ibid.

SECTION IV.

INCLOSING OF LAND.

PAGE.

INCLOSING . . . 99
Advantages of, various . . ibid.
Contributes much to improvements in cultivation . . . ibid.
Produce thereby greatly augmented . . ibid.
Utility of, in producing warmth and shelter . . . ibid.
Promotes the fattening of animals . . 100
Value of land much increased by it . . 101
Some sorts more than others . . ibid.
Turnip soils probably the most . . ibid.
Where necessary or not . . . ibid.
Has not been sufficiently attended to . ibid.
Causes of this neglect . . . 102
Sometimes arises from mismanagement in the direction of inclosures . ibid.
Various circumstances to be regarded in . ibid.
Utility of certain clauses in bills of inclosure . . . 103
Building cottages necessary . . ibid.
Situation of thus improved . . ibid.
Methods of appointing persons to transact the business of inclosure . . 104.
Circumstances to be attended to in . ibid.
Utility of a general act of . . 105
FENCES 107
Circumstances to be regarded in the making of . . . ibid.
Should be regulated by the kind of farm and nature of soil . . ibid.
Effects of different-sized inclosures . . 109
Middle-sized generally most advantageous ibid.
Difference of in grass and arable land . ibid.
Circumstances to be attended to in each ibid.
Advantages of different kinds . . 110
WALLS 111
Different kinds of, described . . ibid.
Advantages of each . . . 111
Nature of foundations of . . ibid.
Modes of making of . . . ibid.
List walls . . . 112
Dry walls . . . ibid.
Middleton's opinion of walls in general . 113
Earth and stone walls, or dikes . . ibid.
Method of forming them, according to Dr. *Anderson* . . . 114
Means of protecting them . . ibid.
May be made cheaply . . . 115
Rendered more lasting by dashing, lipping, and harling with lime . ibid.
In some situations most advantageous for a limited time . . . ibid.
PAILING-FENCES . . . 116
Cannot be generally adopted for farm inclosures . . . ibid.
Different kinds of, described . . ibid.
May often be cheaply made . . ibid.
Utility of in particular cases . . 117
Hurdles or moveable fences . . ibid.
Should be formed of light wood . . ibid.
Circumstances to be regarded in erecting pailing-fences . . . 118
Means of preserving them from decay . ibid.
LIVE HEDGES . . . 119
Attention to situation and soil necessary in raising . . . ibid.
Kind of ground and situation in which different sorts of plants may be most usefully employed . . ibid.
Different advantages of the white and black thorn . . . ibid.
The willow, alder, furz, and beech . ibid.
Circumstances to be regarded in using a mixture of different sorts of plants . 120

CONTENTS.

	PAGE.
Necessary preparation of the land, and the advantages of it	120
Proper season of planting	ibid.
What necessary to attend to in choosing the plants	121
In raising them in the nursery	122
Most advantageous size of	ibid.
Those of equal growth should be planted together	123
The trimming requisite for them	ibid.
Methods of planting hedges	ibid.
Vary much in different districts	ibid.
On ditch banks	ibid.
On sod turned up	ibid.
On the plain surface	ibid.
Different ways of making them	124
Advantages and disadvantages of each mode	125
Methods recommended by Mr. *Middleton*	ibid.
Utility of them	ibid.
What necessary in planting on banks	126
Disadvantage of large banks and ditches	ibid.
Where most useful	ibid.
Planting on the surface without banks	ibid.
Where proper	127
Means of sheltering young hedges	ibid.
Circumstances that prevent quick hedges from succeeding	129
Disadvantages of trees in hedge-rows	130
Modes of managing young live hedges	ibid.
Comparison of with walls	135
Management of old hedges	ibid.
On different situations	ibid.
Directions for raising hedges on land exposed to sea-air	140
DITCHES	142
What necessary in the making of them	ibid.
GATES	143
Various modes of construction of	ibid.
Kinds of wood most useful for	ibid.
What necessary to be attended to in	145
STILES	ibid.
Various methods of making them	ibid.
Observations on fences in general	ibid.
On the means of making, managing, and preserving them	146

SECTION V.

CONSTRUCTION OF ROADS.

	PAGE.
ROADS	148
Advantages of, various	ibid.
Circumstances to be attended to in the direction of	ibid.
Different forms of, considered: the convex; the concave; the varieties of flat forms	149
No particular form suitable perhaps for all situations	150
Various circumstances in regard to forms stated	ibid.
Some objections to the convex form	151
Probably not well founded	152
Concave form found advantageous in Leicestershire	153
Peculiarities in the flat forms, described	ibid.
Objects generally aimed at in all	154
Beatson's theory of roads	ibid.
Form of the basis or bottom, of much importance	155
Application of certain principles in construction of	ibid.
Different circumstances to be attended to in	156
Various advantages of such construction described	157
Manner of forming the drains in	ibid.
Where made on this plan, roads need not be so wide	158.
Much land may consequently be saved	ibid.
The quantity of estimated	ibid.
Different soils require a difference in the construction of roads	ibid.
Methods of making them in sandy	ibid.
In clayey	159
In boggy soils	160
On the sides of hills	161
Should be kept from having water running on them in every construction	162
Modes of constructing iron or railed roads	ibid.
Advantages of	163
Where most useful	ibid.
REPAIRING ROADS	ibid.
Communication on parochial roads	166
Defects of	ibid.
Means of improving them	167
Wheels of particular forms injurious to roads	168
Different effects of the conical and cylindrical	ibid.
Latter most advantageous	ibid.
Cummings's estimate of the difference in the effects of	169
Forms of roads that are the least affected by wheels in general	173

CONTENTS.

	PAGE.		PAGE.
Fences on the sides of roads	. 174	Circumstances necessary to be attended	
Disadvantages of them	ibid.	to in them	. 174

PART THE SECOND.

SECTION VI.

SOILS.

	PAGE.		PAGE.
SOILS	. 176	Applications proper in this view	185
Manner in which they are formed	ibid.	Reasons for their being more easy of tillage	186
Reason of their variation of quality	ibid.	Not so disposed to the production of weeds	ibid.
Cause of their different degrees of fruitfulness	ibid.	CHALKY SOILS	187
They are injured by some substances	177	Circumstances which produce differences in them	ibid.
Kinds which have this effect	ibid.	State of the calcareous matter incorporated with them, must be attended to	ibid.
Reasons why those which are apparently similar, turn out different on their being broken up	ibid.	The combination of other substances with the calcareous, alters its effects	ibid.
Causes of the contradictory facts respecting, in agriculture	178	In union with magnesia, is prejudicial to vegetation	188
Causes of soils producing one sort of crop in preference to another	ibid.	Causes which form distinctions in	ibid.
Depth and quality of sub-soils	ibid.	Applications suitable for improving them	189
The cause of differences in them	ibid.	Reasons why much strength of draught is required in	190
Causes of the difficulty of ascertaining	ibid.	Great attention to the tools employed on, always necessary	ibid.
Methods in which attempted	179	SANDY SOILS	ibid.
Chemical analysis	ibid.	Mode of formation of	ibid.
Natural appearances	ibid.	On what their variation depends	ibid.
Nature of plants produced by	ibid.	Why less benefited than others by heat and moisture	191
Advantages of each	ibid.	Circumstances to be attended to in improving them	ibid.
Necessary to have recourse to experience	ibid.	Applications proper in different cases	ibid.
Have been described under a variety of useless local terms	180	Reason why different applications are useful in different districts	ibid.
May be distinguished under a few heads	ibid.	Means of supplying them with vegetable matter	ibid.
CLAYEY SOILS	ibid.	Methods in which manures may be applied to them	192
Causes of the differences of	ibid.	Thin soils easily cultivated	ibid.
Circumstances to be attended to in improving them	181	Causes of the disadvantages of	ibid.
Applications most useful for	182	GRAVELLY SOILS	ibid.
Methods of laying them on	ibid.	Materials of which composed, various	ibid.
Advantage of proper modes of tillage in	183	Different arrangements of	193
Necessary to be kept as dry as possible at all seasons	ibid.	Why subject to burn	ibid.
Advantages of this practice in different cases	ibid.	Defects of, how removed	ibid.
Circumstances to be attended to in their tillage	ibid.	Applications proper for in different cases	ibid.
Means of ascertaining their nature	184	PEATY OR MOSSY SOILS	194
LOAMY SOILS	ibid.	Met with extensively in some districts	ibid.
Admit of variety	ibid.	Causes of the varieties of	ibid.
Substances of which composed	ibid.	Stratified order of	ibid.
Manner in which they recede from clays	ibid.	Cause of great differences in	195
Circumstances on which their lightness and friability depend	185	Highly retentive of water	ibid.
On which their colours depend	ibid.	Injured by its evaporation	196
Admit of improvement more readily than clays	ibid.		

	PAGE.
Means of improvement in	196
Applications necessary for	ibid.
VEGETABLE EARTH, OR SOIL	197
Nature of, in different cases	ibid.
Formation of, how effected	ibid.
Oxygenation supposed to retard the destruction of	198
Means of promoting the increase of	199
Causes which render it too light for grain crops	200

SECTION VII.

MANURES.

	PAGE.
MANURES	202
Changes undergone in substances in the formation of	ibid.
Fluid, elastic, and volatile matters, chiefly prepared in the soil	ibid.
Are in different proportions according to circumstances	203
The more gross matters applied to lands chiefly termed manures	ibid.
Changes necessary in these to fit them for the support of vegetation	ibid.
Much difference in, according as they abound with certain substances or principles	ibid.
This probably the cause why some matters are so superior to others when used equally	ibid.
Other modes in which they contribute to the growth of crops	ibid.
Difficulty of arrangement of	204
May probably be usefully divided into animal, vegetable, fossil, saline, and compound manures	ibid.
MANURES FROM THE DECOMPOSITION OF ANIMAL SUBSTANCES	ibid.
How they contribute to the support of plants	ibid.
Differences in the constituent principles of, may produce differences in their effects	205
Their tendency to putrefaction	ibid.
How promoted	ibid.
Circumstances to be attended to in	ibid.
HARD ANIMAL SUBSTANCES	206
Different natures of	ibid.
Bones, horns, hoofs, and others	ibid.
Circumstances to be attended to in their preparation, mixture, combination, and application	ibid.
SOFT ANIMAL SUBSTANCES	207
Various kinds of	ibid.
Greaves; sugar-scum	ibid.
Refuse of manufactories	210
Fish, blood, &c.	ibid.
Circumstances to be regarded in their preparation	210
In their combination and mixture with other matters	ibid.
In their application and use	ibid.
Woollen rags, hair, feathers, &c. probably of inferior advantage	211
Animal of more durable effect than many other substances	ibid.
ANIMAL DUNGS	ibid.
Nature and goodness of	212
On what this latter depends in general	ibid.
Kinds of employed	ibid.
Effects of, how produced	ibid.
Night-soil	213
Of birds and other animals	214
Circumstances to be attended to in the collecting of	215
Of swine	ibid.
Of horses and cows	ibid.
Attentions in the mixing of with other substances	216
Of sheep	ibid.
Attentions in the application or use of on land	ibid.
MANURES FROM THE DECOMPOSITION OF VEGETABLE SUBSTANCES	ibid.
Methods in which they are prepared for the support of plants	ibid.
Different matters suitable for, formed during the decomposition of	ibid.
Reasons why they differ in their effects on land	219
Substances that may be used, various	ibid.
Refuse vegetable substances	ibid.
Manner in which they may be rendered useful	ibid.
Green crops	220
Sea weed	221
Tanners' bark	222
Mud from various places	223
Malt-dust	ibid.
Refuse of oil-cakes, &c.	ibid.

	PAGE.
MANURES FROM THE AGENCY AND DECOMPOSITION OF FOSSIL SUBSTANCES	224
Calcareous matter in general	ibid.
Reason of the different effects of, in different cases	ibid.
Why it may vary when prepared from different substances	225
Lime, or calcined calcareous matter	ibid.
Effects of in its active state, or that of quick-lime	ibid.
In its effete state, or that of carbonate of lime	227
From its combinations with different substances	ibid.
From its containing phosphorus	ibid.
General remarks on the use and application of lime	229
Lime stone	232 note.
May be employed as a manure without calcination	235
Manner of preparing it for use in this state	ibid.
Different effects of, when thus applied	236
Soils on which most useful	ibid.
Lime stone gravel	ibid.
Manner of rendering it more generally useful	ibid.
Chalk	ibid.
Nature of	ibid.
Mode of using it with the greatest chance of success	ibid.
Effects of on various kinds of soil	ibid.
Proportions in which applied on each kind	237
Marle	238
Different kinds of, noticed	ibid.
Manner of ascertaining them described	ibid.
Agree in some properties	239
Manner in which they should be applied in different cases	ibid.
Proportions in which they may be employed	240
Used on tillage and grass lands	241
Circumstances to be attended to in their application in each case	ibid.
Particulars to be regarded in repeating the application of	ibid.
Mr. Holt's estimate of their expence	243 note.
Sea sand	244
Utility of, as a manure	ibid.
Soils on which it may be employed	245
Quantity to be used	ibid.
Mode of application	ibid.
Common sand	246
Nature of	ibid.
How it may be useful on land	246
MANURES FROM THE AGENCY AND DECOMPOSITION OF SALINE SUBSTANCES	ibid.
Different sorts of, may be used	ibid.
Modes in which they produce their beneficial effects	ibid.
Nature of particular substances explained	247
Bleachers' refuse	ibid.
Soap-boilers' waste	ibid.
Vegetable ashes	248
Peat ditto	249
How to be applied	250
Coal ashes	251
Soot	252
Modes in which it may be useful as a manure	ibid.
Manner of applying it	ibid.
Reasons why substances containing saline matters should be preserved in sheds	253
Muriat of soda, or sea-salt	ibid.
Utility of as a manure, not well ascertained	ibid.
How it may promote putrefaction	ibid.
Other ways mentioned in which it may be usefully employed	254
MANURES FROM THE COMBINATION OF DIFFERENT SUBSTANCES	255
Farm-yard compost	ibid.
Nature of substances from which formed	256
Means of promoting its formation	ibid.
Manures may frequently be used with more advantage when combined, than in their simple states	ibid.
Circumstances necessary to be regarded in the mixing of	ibid.
Manures much increased in this way	ibid.
Cautions to be regarded in using different substances	ibid.
Lime in its different states, alkaline, saline matters	257
Quantities of such manures necessary to be applied to land in different cases	259
Circumstances that must be attended to in their use in this way	260
MEANS OF AUGMENTING AND PRESERVING MANURES	261
Waste of all sorts of substances to be prevented	ibid.
To be reduced more quickly into the state of manure	ibid.
Attention to the form and construction of the farm-yard necessary	ibid.
Form of, described	262

	PAGE.
Manner of proceeding with different vegetable matters in	262
By mixing of lime with	265
By preventing evaporation	ibid.
By collecting different sorts of materials	ibid.
By folding sheep	267
By managing different green crops	268
By preventing the waste of the soil of privies	ibid.
By attention to the saving of different animal matters	270
By collecting vegetable earth	271
By the proper management of dunghills	ibid.
GENERAL APPLICATION OF MANURES	272
States of, in which they may be applied with most advantage	272
Modes of applying in different cases	273
To arable lands	ibid.
To grass lands	ibid.
Seasons in which their application may be best performed in different instances	ibid.
Circumstances respecting their putting into land, described	274
When applied on the surface, what necessary to be attended to	ibid.
Means of applying them in the most saving way	277
Kinds of manure that may be used to most advantage in different cases	278

SECTION VIII.

DRAINING OF LAND.

	PAGE.
MUCH water necessary to the healthy growth of plants	281
Highly injurious to, when retained in or upon soils in over-proportions	ibid.
Hence the necessity of removing it, by draining such lands previously to other improvements	ibid.
Circumstances on which the successful performance of this business depends	282
The different stratified nature of the ground to be attended to	ibid.
Distinction of the strata in different cases	ibid.
In elevations or hills	ibid.
In lower grounds	ibid.
Reason of their irregularity in different instances	ibid.
Manner in which water is formed and collected on elevated situations, and brought down to the lower ones	283
Different watery appearances produced thereby; as swamps, morasses, oozing springs, weeping rocks, large springs, rivulets, &c.	ibid.
Break out at different distances, according to the nature and regularity of the stratum on which the water passes	ibid.
On what the difference of force depends in different cases	ibid.
Nature of the impervious strata on which the water is conducted	284
Clayey and compact marly strata, chiefly the kinds on which water is conveyed	ibid.
They extend to different depths in different cases	ibid.
The clayey generally the more superficial	284
Nature of the intervening porous materials in different cases	ibid.
Different situations of ground in respect to wetness	285
Methods of removing it in different cases and situations of land	ibid.
Circumstances to which attention should be paid in this view	286
Causes from which wetness as respecting agriculture mostly arises	ibid.
General methods of removing, by intercepting the water of springs	ibid.
Different cases of this	287
By cutting of drains	ibid.
By perforating, by means of the auger	ibid.
Cases where the common method of cutting various deep drains may be practised with success	ibid.
Where perforating the thin impervious strata to the open porous ones may be made use of	ibid.
Circumstances that tend to show the presence of springs	289 note.
Cases in which water may be intercepted by cutting into the sides of elevated grounds, and carried off by suitable means at high levels	290
Drainage of lands lying below the level of the sea, only to be effected by expensive machinery	ibid.
Encircling them with large ditches might be beneficial	ibid.

CONTENTS.

PAGE.

Surface wetness, from the retentive nature of soils and peculiarity of situation, removed by hollow superficial drains properly formed . . 290
In grass land . . ibid.
In arable land . . ibid.
METHODS OF DRAINING BOGGY LANDS . . 291
Circumstances on which it depends in different cases . . ibid.
Manner of levelling for . 292 note.
Different directions of the strata produce differences in . . 293
Means of ascertaining the principal spring, in cutting drains . . 294
Effects of cutting them improperly . ibid.
Cutting in cases of irregular banks . 295
Mode of draining in narrow confined bogs, where the porous stratum containing the water unites at but little depth below the retentive material . 296
In those of a more extensive kind . 297
In marshy or hollow lands adjoining rivers ibid.
Modes of forming the drains in these cases . 299
Kinds of most useful . . 301
Sorts of materials employed in filling them 302—323
Nature of bricks used in constructing them . ibid. 326
What requisite to be attended to in putting in the earth afterwards . . 303
Signs of stoppage of . . ibid.
Mouth of drains to be guarded . . ibid.
Circumstances which show the drains to be effectual . . ibid.
Method of drainage where the under stratum is porous, different from that of those just described . . 304
Drains to be made in the most depending parts, through the upper surface soil to the retentive stratum . . ibid.
Boring then necessary to let down the water . 305
Same purpose effected by deep pits or wells ibid.
Drains in those cases to be made narrow, and filled with stones . . ibid.
Attention necessary in forming the ridges, when the land is to be in tillage . ibid.
Nature of porous stratum first to be ascertained . . . ibid.
METHODS OF DRAINING HILLY LANDS . . 306

PAGE.

Drainage of hills or elevated pasture-grounds, what necessary to be attended to in . . 306
Drains made according to the position of the strata . . ibid.
Trenches necessary to be formed high up in the wet soil, to intercept the springs . 308
Other cuts lower down, requisite in some cases . . . ibid.
Both sides of hills may often be drained by cutting into the dryer . . ibid.
Houses conveniently supplied with water in such cases . . ibid.
May sometimes be raised to a great height in . . . 309
The cuts or bores not to be made too deep in these cases . . ibid.
METHODS OF DRAINING MIXED SOILS . . . ibid.
Reason why more generally expensive . ibid.
Manner of cutting the drains in . . ibid.
Means of ascertaining the best situation for . . . 310
Modes of in several varieties, described . 311
Reason why the drains should be cut in a horizontal direction . . 312
Fewer drains necessary in these soils . ibid.
Cause of, explained . . ibid.
METHODS OF DRAINING RETENTIVE SOILS . . ibid.
Of forming the drains in the different cases . 313
By the plough, or the spade ibid. 318, 319
Other cases of . . . 313
Implements made use of in cutting them 320
The miner (see p. 12) . . 322
Best season for making them . . ibid.
Size of, in different instances . . 323
Materials for filling them . . ibid.
Expense and duration of, in different cases . 324 note, 325
METHOD OF DRAINING MINES, QUARRIES, AND PITS . 327
Circumstances to be attended to in different cases . . . 328
By cutting off the springs . . ibid.
By letting the water down into the porous stratum below . . ibid.
Uses to which water may be converted in some instances of this kind . 330
Observations on draining in general . 331

SECTION IX.

PARING AND BURNING.

PAGE.

PARING AND BURNING . . 335
Practice of, adopted at an early period . ibid.
A process in which various changes are produced in soils . . ibid.
Some of which probably lessen fertility ibid.
Others greatly promote it . . ibid.
Consumption of vegetable and animal matters prejudicial . . ibid.
The conversion of the fresh vegetable product into saline matters, highly beneficial . . . ibid.
Combination of oxygen with the soil, of great utility . . . ibid.
The saline matters seem to be the cause of the great luxuriance of crops afterwards . . ibid.
Must tend to exhaust the land . ibid.
Great stimulant power of, useful in promoting vegetation . . 336
Manner in which lime may be useful when used with the ashes . . ibid.
Injury only done by the loss of vegetable or animal matters . . ibid.
The earthy matter not capable of being lessened by it . . ibid.
Frequently left in a more pulverizable state . . ibid.
Loss of vegetable matter probably not so much as supposed by some writers ibid.
Ashes produced in the process, shown to be highly useful . . 337
Nature of the saline substances . ibid.
Fixed alkali, and vitriolated tartar, both useful for the purpose of vegetation . ibid.
Other modes in which the process may be useful in promoting the growth of crops . . ibid.
By the reduction of all sorts of coarse vegetable materials . . ibid.
Rendering them more readily acted upon by other substances in the soils . ibid.
By preventing the land in this way from becoming too open and light for grain crops . . ibid.
By the earth in many cases being rendered more mellow and fine, and thereby more suitable for the reception of the roots of growing plants . 338

PAGE.

By the complete destruction of weeds, in some instances, the lands are more at liberty to support the cultivated crops . . 338
The practice porbably more adapted tosome sorts of lands than others . . ibid.
Least useful on the thin light soils, or such as have been in tillage . ibid.
Most advantageous on the stiff, heavy, coarse, and sour soils, or such waste lands as are infested with coarse productions of any kind . . ibid.
This supported by the general experience of agricultors . . 339
The reason of, explained . . ibid.
The opinion of an able writer upon . ibid.
On mossy or peaty soils must be practised with great caution . . 340
Improper for the operation in some cases . . ibid.
Dr. Anderson's opinion against the practice on . . ibid.
A fact respecting, in other sorts of land . ibid.
Improper management probably the cause of this . . . ibid.
May however sometimes be employed on them . . ibid.
More caution necessary than in other soils ibid.
The practice general on the coarse, waste, heavy sorts of soil . . 341
Utility and advantages of, acknowledged by most writers on agriculture . ibid.
Mr. Middleton's opinion of, in breaking up land . . ibid.
Opinions of others stated . . 342
Causes of objection to the practice of paring and burning . . ibid.
Origin of these . . . ibid.
No loss of soil in, but from the vegetable or elastic matters . . ibid.
This not so great as supposed . 343
Clayey soils supposed by some to be most liable to injury from improper management of . . ibid.
By others supposed useful in mellowing the soil . . . ibid.
Mr. Young's opinion of the objections made in fen districts . . ibid.

	PAGE.
Facts show little danger to exist when properly performed	344
Differences in the method of performing the operations	ibid.
Probably necessary from the differences of soil	ibid.
Manner of proceeding most useful in different cases	ibid.
Skirting	345
Beat-burning	ibid.
Implements employed in the performing of, different	ibid.
Advantages of each	346
Ploughs most expeditious when they can be used	ibid.
Season for the process	347
Dry weather highly necessary	ibid.
Spring months generally the best	ibid.
Must vary, from the nature of crops	ibid.
For rape and turnips	ibid.
For barley and oats	347
For wheat	ibid.
Thickness of parings should depend on the nature of the soil	ibid.
Mr. Boys's opinion of	348
Usual depths of	ibid.
Circumstances to be regarded in spreading the ashes	ibid.
Particular mode of, in some places	ibid.
Objections to	ibid.
Expences of, in lighter sorts of soils	ibid.
In fen districts	349—351
Manure produced by	ibid.
Most advantageous methods of cropping after the process in different cases	ibid.
Estimates of the expence and profits of	353
Utility of the practice	355
How may be rendered less necessary	ibid.
General observations on	356

SECTION X.

FALLOWING OF LAND.

	PAGE.
FALLOWING	358
In preparing lands by means of, various changes take place in the substances that form soils	ibid.
A high degree of mellowness and pulverization mostly effected by it	ibid.
By such means the different materials become more uniformly and extensively blended together	ibid.
Advantages of this in the growth of crops	ibid.
Dews and moisture more readily admitted thereby	ibid.
Destruction of weeds in, also useful in improving the soils	359
Other modes in which pulverization may be beneficial	ibid.
By admitting the atmospheric air more abundantly into the interstices of the soils	ibid.
By the formation of carbonic or other acids in consequence of it	ibid.
Of ammonia, or volatile alkali	ibid.
Of nitrous acid	ibid.
Of fluid carbonic acid	ibid.
The practice of fallowing in these ways more extensively beneficial than has been supposed	360
Is more adapted to some sorts of land than others	ibid.
In some, unnecessary or injurious	ibid.
On the lighter and more dry soils	360
On such as are rich from the application of manures	ibid.
Manner in which it proves hurtful in each	ibid.
Useful in the wet, stiff, and tenacious clayey soils, in various ways	361
By permitting atmospheric air to enter more fully into the cavities of the soils, the matters that promote vegetation are more extensively produced	ibid.
The roots of plants allowed to penetrate and take them up more freely by the great increase of surface that thus takes place	ibid.
The destruction of weeds more effectual in this way	ibid.
Can only perhaps be effected in wet soils by summer fallowing	ibid.
Ploughing them in winter often renders them more stiff and adhesive	362
Dry gravelly soils may mostly be managed without this process, but wet and clayey ones cannot	ibid.
No modes of cropping perhaps fully effectual in the latter	ibid.
On such soils they will not therefore obviate the occasional use of summer fallowing	ibid.

	PAGE.
May sometimes lessen the necessity of its being repeated	362
Without this process many useful products could not probably be formed in the soils so as to promote vegetation	363
Green crops are, however, necessary to be cultivated as much as possible, with the view of keeping stock	ibid.
Sorts of plants most useful on, in this way	ibid.
Ruta baga	ibid.
Peas	ibid.
Wheat	364
Clover	ibid.
From the great varieties in such soils, differences in the use, repetition, and modes of fallowing, may be necessary	ibid.
These should be attended to by the agricultor	ibid.
Methods of performing it should be varied according to soil and circumstances	ibid.
Modes of, in different cases, described	ibid.
Properest times of performing the different ploughings	364
How full pulverization may be best effected in	365
Different methods in which ploughing may be done with the most advantage in respect to the aëration of the soils	ibid.
Ploughings asserted by some to be only necessary	ibid.
Difficult in some cases to prepare stiff soils in this way	367
Their cloddiness prevents the root weeds from being destroyed	ibid.
Only effectually destroyed by the pulverization of frequent harrowing and rolling	367
Picking off the weeds sometimes practised after	ibid.
This method economical, by rendering fewer ploughings necessary	ibid.
Frost more powerful after	ibid.
Little danger of such soils being made too fine	ibid.
This proved by experiment	ibid.
Other methods of fallowing that have been recommended, too intricate to deserve the attention of farmers	368
What necessary to be regarded in the application of manures after, in different cases	ibid.
This sometimes wholly unnecessary	ibid.
Frequently found more useful for the second crop after	369
Reasons why the cultivation of full green crops may often be more useful	ibid.
Depends probably on several causes	ibid.
Land always left more fine and mellow after large green crops are grown	370
Why they seem to improve the land more than light poor crops	ibid.
Hence also more advantageous to the cultivator than naked fallows	ibid.
Should be more frequently introduced both on light and heavy soils	ibid.
Are admissible on the latter more frequently than is in general supposed by farmers	ibid.
How best managed on	ibid.
Observations on green fallows in general	ibid.

SECTION XI.

CULTIVATION OF ARABLE LAND.

	PAGE.
CULTIVATION OF ARABLE LANDS	373
Considered in regard to those that have not been under the plough, and such as have been in a state of tillage	ibid.
In the first sort many preparatory operations necessary to be performed	374
REMOVAL OF VARIOUS OBSTRUCTIONS TO PLOUGHING	ibid.
Stones	ibid.
Different kinds of	ibid.
How best performed	ibid.
Necessity of in different cases, explained	376
May frequently be converted to useful purposes	ibid.
Land proprietors should be at part of the expense of	376
Clearing from wood	ibid.
Different according to circumstances	ibid.
How performed in trees of the timber kind	ibid.
By trenching with the spade	377
By the plough	ibid.
When the roots have been somewhat removed, a crop may be taken	ibid.
Afterwards more effectually cleared	ibid.
Mostly a better practice to do this at first	ibid.
Reason of which, explained	ibid.

PAGE.

Manner of in plants of the shrubby kinds 377
Different plants prefer different kinds of soil ibid.
Broom; bramble; furze; thorn; dwarf willow . . . ibid.
Soils on which each grows most luxuriantly described . . ibid.
Alteration of by the application of suitable substances, how advantageous in destroying them . . ibid.
Substances to be applied in this view . 378
Methods of extirpating them when grown large . . . ibid.
The practice of burning in the furze kind, to be avoided as much as possible . . . ibid.
Necessary to keep such lands in tillage till there is time to fully destroy them . ibid.
When laid down to grass, most beneficial to be pastured with sheep . . ibid.
Heath 379
Nature of the land on which produced . ibid.
Affords less vegetable matter for improvement of than other plants . ibid.
On this account less friendly to the growth of useful crops . . ibid.
Practices to be adopted in removing it and in bringing the ground into tillage ibid.
By cutting . . . ibid.
By paring and burning . . ibid.
By burning only . . 380
What necessary to be attended to in each ibid.
Implements most useful in cutting it . ibid.
Lime necessary to be applied to in its caustic state . . . ibid.
In large proportions . . ibid.
Mr. Young's opinion of . . ibid.
Manner of doing it . . ibid.
Should be in a fine powdery state and equally spread out . . 381
Soon produces beneficial effects . ibid.
Methods in which they are effected . ibid.
Slight tillage necessary after . ibid.
Cases in which it may be destroyed without breaking up . . ibid.
Modes of cropping on in different instances 382
Principal object in, to be laid down to grass ibid.
Green crops to be eaten off, essentially necessary to . . . ibid.
Turning down green crops, sometimes practised on . . ibid.
Not so useful as feeding them on the land . . . ibid.
Cases in which it may be employed . ibid.
Should be returned as soon as possible to grass . . . ibid.
Other descriptions of land approaching to this . . . ibid.

PAGE.

Such as are productive of rushes and other coarse plants . . 383
Of ant-, mole-, or other sorts of hills . ibid.
Much effect produced in the first kind by draining . . . ibid.
Utility of paring and burning in . ibid.
Other methods suggested as more advantageous . . . ibid.
Mixing the turfy surface with caustic lime supposed a less wasteful plan ibid.
Reason why it may in some cases be usefully employed . . 384
Ant-hills may be mixed in the same way . . . ibid.
Proportion of lime should not be too great . . . ibid.
Method of by the flay-plough sometimes very useful . . . ibid.
Stiff, wet, clayey soils . . 385
Modes of tillage in . . . ibid.
Deep stirring often necessary . . ibid.
This often effected by the miner . ibid.
Dr. *Anderson*'s opinion of its utility . ibid.
Manner in which it drains the land . ibid.
Other modes of accomplishing it described 387
Manner of rendering such soils mellow and fine by lime . . 388
The necessity of paring and burning lessened in this way . . ibid.
But must be employed in old tough swards abounding with rough plants ibid.
Repeated ploughing frequently necessary in breaking up wastes . . ibid.
Different intentions of . . ibid.
Nature of soil, climate, kind of crop, and method of sowing, to be considered in . . . ibid.
Manner of levelling the land . . 389
Implements employed in . . ibid.
Kinds most useful . . ibid.
Manner of bringing boggy lands into tillage . 390
Crops most proper for . . 391
Deep mossy soils . . . ibid.
Methods of cultivating them . ibid.
By floating the moss . . ibid.
By the application of lime without floating . . . 393
Methods that have been followed in Scotland mentioned . . ibid.
Method of applying the lime on . 395
Quantity made use of . . ibid.
Manner of sowing the crops on . . 396
Crops most proper to be cultivated on ibid.
Close thick green ones most suitable ibid.
Potatoes; turnips; winter rye; rape . ibid.
Grain crops; proper sort of for . . 397

CONTENTS.

PAGE.

Grass seed; kinds of proper for . . 397
Methods of tillage in, described . ibid.
RIDGES . . . 398
What necessary to be attended to in forming ibid.
On clayey or loamy soils . . 399
On marshy land . . . ibid.
On sandy and gravelly soils . . ibid.
On peaty or mossy soils . . 400
Ridges in these latter, mostly formed by the spade . . ibid.
Manner of performing the work in . ibid.
May be increased in breadth in deep soils of this kind . . ibid.
General direction of in all sorts of soils . ibid.
North and south, the most proper . ibid.
Methods of forming them in hilly lands . 401
Advantages of in different cases described ibid.
Altering ridges on old cultivated lands. . 403
What necessary to be regarded in . 404
Modes of performing in different instances ibid.
Mechanical contrivances disadvantageous in ibid.
An improved method recommended by an experienced writer . . 406
Expense of in different ways . . 407
Other modes of levelling ridges described . 408
The plough should be mostly employed for . 409
PLOUGHING . . . ibid.
Circumstances to be attended to in performing . . . 410
In heavy soils . . . ibid.
In light soils . . . 411
Depth of in different cases . . ibid.
Frequency of ploughing different according to the soil . . . 413
Repeated stirring in general, more necessary on the stiff and heavy soils, than those of the lighter kinds . ibid.
On soils long in tillage, generally less necessary . . . ibid.
For drilling land should always be in a fine state of tillage . . ibid.
Nature of crops mostly directs the frequency of ploughing lands . . ibid.
Some sorts demand more tillage than others . . . . ibid.
A fine state of tilth generally favourable ibid.
Tull's opinion of tillage in general . ibid.
Crops liable to be much injured by weeds should always have land well prepared by tillage . . 414
May often be done by the growth of plants that demand frequent culture while growing . . . ibid.
By such as have large roots of the tap or knobby kind . . ibid.
Reasons why land in a fine state of tilth is most favourable to vegetation . ibid.

PAGE.

Implements of the plough kind most proper for performing the business in different sorts of land described . 414
Suffolk iron swing-plough; the Rotheram plough; and Small's plough . ibid.
Importance and advantages of ploughs being properly constructed . . ibid.
HARROWING . . . 415
Different utility of . . . ibid.
Kinds of harrows to be employed in different cases . . . ibid.
Manner of being made use of in . ibid.
Draggs; scufflers; scarifiers; and cultivators . . . ibid.
Fixed harrows often useful in preparing land 416
Methods of harrowing to cover the seed in different cases described . . ibid.
Proper season of performing the business in different soils . . ibid.
Particular manner of accomplishing the work in wet poachy soils . 417
Disadvantage of this mode stated . ibid.
How performed when grass seeds are sown ibid.
ROLLING . . . ibid.
Utility of in different views . . ibid.
In the way of breaking down the lumpiness in heavy soils . . 418
How it proves useful in destroying weeds and rendering the land level. . ibid.
MANURING of tillage lands . . ibid.
Attentions requisite . . ibid.
Kinds of manure proper for, in different cases . . . 419
On heavy soils . . . ibid.
On those of the middle sort . . ibid.
On marshy soils . . 420
On light soils . . . ibid.
On mossy or peaty lands . . 422
Nature of the crops to be attended to in . ibid.
Reasons of explained . . ibid.
Proper modes of laying on for particular sorts of crops . . ibid.
Modes of performing the business under different methods of culture . 423
Manner in which manures should be chiefly employed . . ibid.
Depths to which deposited . . 424
Quantities in which made use of . 425
Seasons in which beſt applied . . ibid.
General attentions . . 426
Calcareous substances . . ibid.
Sundry (animal and other) substances . 428
Expenſe, estimate . . . 430
Seasons for application . . 431
PLOUGHING IN GREEN CROPS . . 432
SHEEP-FOLDING . . . 433
Modes of performing it . . ibid.

	PAGE.
Where most useful in this view	434
Green crops	ibid.
Attentions in the execution of	ibid.
WARPING	435
Method of performing	ibid.
Principle by which the benefit of, is produced	436
Directions for the performance of, note	ibid.
Soils most proper for	437
Expense of	ibid.
Most eligible crops afterwards	438
SOWING	438
Attentions in, indispensably necessary	ibid.
Theory of vegetation	439
Attentions in the choice of seed	ibid.
Criterions of the goodness of	442
For ascertaining such as has been burnt in the stack	443
Change of seed, when necessary in different views	ibid.
Modes of preparing the seed	445
Reasons of	446
Utility and advantage of, in various instances	ibid.
Broadcast, or what is commonly termed the *old* method, described	457
Where capable of being practised with advantage	458
Other methods more useful in some cases	ibid.
Drilling, or what is called the new method, explained	459
This probably older than the other	ibid.
Where capable of being employed to moft benefit	461
What necessary in	ibid.
Implemen s most suitable for	468
The advantages of each method shown	476
Comparative statements of, under different circumstances	480
Culture necessary in each method during the growth of crops	495
HOEING	496
Kinds of implements most proper for in different cases	500
WEEDING	504
Implements proper for	505
ROTATION OF CROPS	508
Importance and utility of	ibid.
Those most proper in different sorts of soils	509
Courses of crops	511
Particular methods of cultivating various sorts of crops	538
Wheat	539
Rye	567
Barley	571
Oats	577
Beans	590

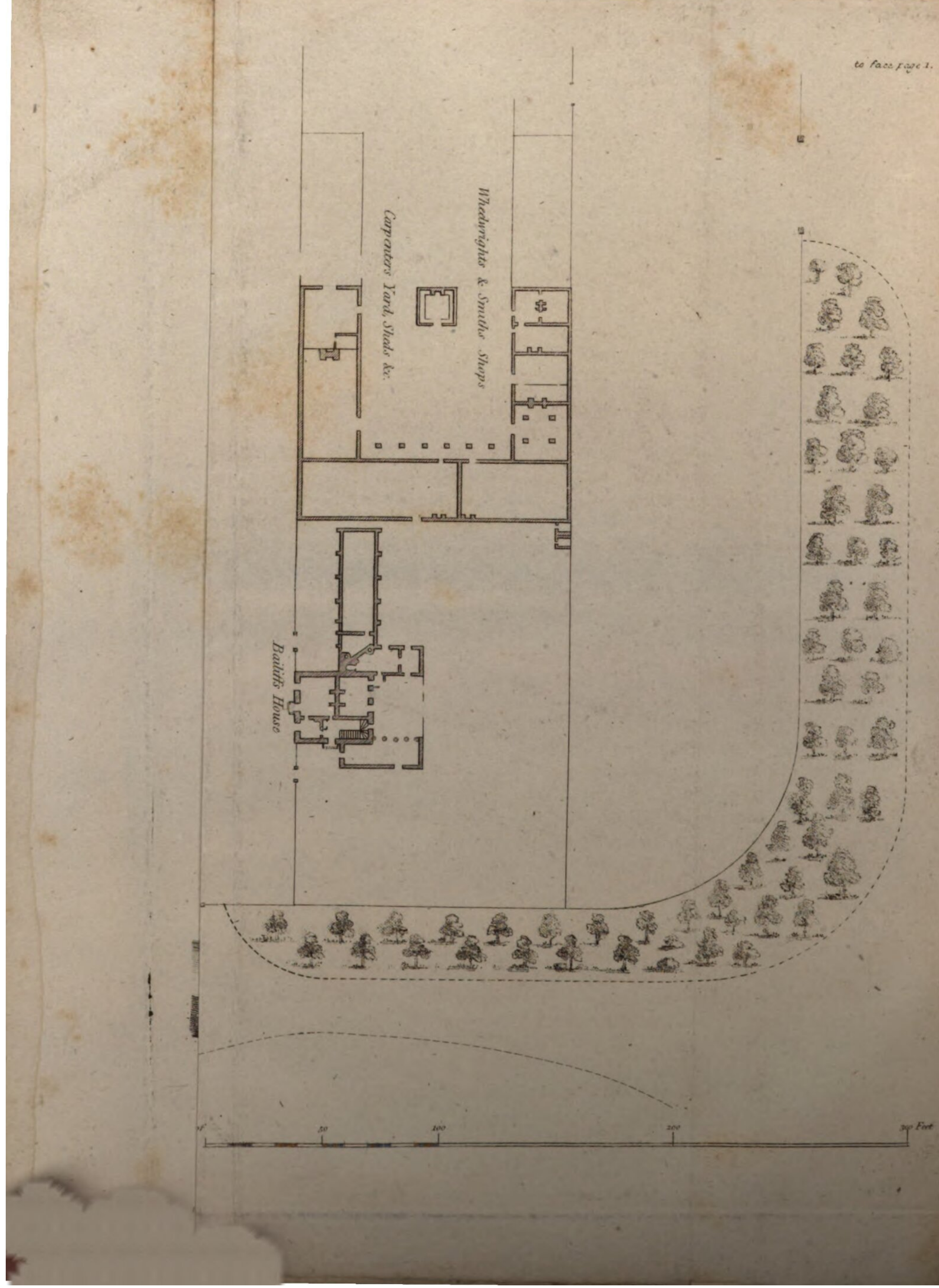
LIST OF PLATES*

IN THE FIRST VOLUME.

Plate

I. Plan of Woburn Farm-yard.
II. Swing Plough. ..... to face Page 40
III. Kentish and Norfolk Plough ..... ibid.
IV. Common Wheel Plough ..... ibid.
V. Double Wheel Ploughs. ..... ibid.
VI. Improved Wheel Ploughs ..... ibid.
VII. Draining Ploughs ..... ibid.
VIII. Drill Machines. ..... ibid.
IX. Horse Hoes. ..... ibid.
X. Cultivators ..... ibid.
XI. Common Harrows ..... ibid.
XII. Improved Iron Harrow ..... ibid.
XIII. Rollers ..... ibid.
XIV. Thrashing Machines ..... ibid.
XV. Chaff Cutter ..... ibid.
XVI. Norfolk and Suffolk Horse Rake ..... ibid.
XVII. Carts and Waggons ..... ibid.
XVIII. Barns. 64
XIX. Stacking Apparatus and Granary ..... ibid.
XX. Horse Stables and Single Cattle Sheds. ..... ibid.
XXI. Double Cattle Sheds ..... ibid.
XXII. Dairy-House and Implements ..... ibid.
XXIII. Steam Boilers and Bruising Machine ..... ibid.
XXIV. Mills. ..... ibid.
XXV. Dairy Farm Houses and Offices 71
XXVI. Corn Farm Houses and Offices 72
XXVII. Mixed Farm Houses and Offices ..... ibid.
XXVIII. Farm Cottages 92
XXIX. Wall and Earth Fences. 110
XXX. Paling Fences ..... ibid.
XXXI. Hedge Fences ..... ibid.
XXXII. Hedge Fences. ..... ibid.
XXXIII. Hedge Fences ..... ibid.
XXXIV. Gates and Stiles. 143
XXXV. Construction of Roads. 174
XXXVI. Construction of Roads ..... ibid.
XXXVII. Implements for repairing Roads ..... ibid.
XXXVIII. Embankments ..... ibid.
XXXIX. Drainage of Boggy Lands from Springs 332
XL. Drainage of Boggy and Wet Lands ..... ibid.
XLI. Drainage of Low Swampy Lands ..... ibid.
XLII. Drainage of Hilly Lands and Mixed Soils. ..... ibid.
XLIII. Drainage of Land where the Soils are porous above and retentive below ..... ibid.
XLIV. Drainage of Land in various Soils. ..... ibid.
XLV. Drainage of Mines, Quarries, &c. ..... ibid.
XLVI. Drainage of Water from Minerals, &c. ..... ibid.
XLVII. Mole-Plough ..... ibid.
XLVIII. Sections of Drains ..... ibid.
XLIX. Draining-Bricks. ..... ibid.
L. Paring Plough 356
LI. Hand Hoes. 500
LII. Useful Horse Hoe. 505
LIII. Horse Hoeing 507

* The descriptions must face the plates to which their numbers refer.


Wheelwrights & Smiths Shops
Carpenters Yard, Sheds &c.
Bailiffs House
50
100
200
300 Feet

PRACTICAL AGRICULTURE.

SECTION I.

Implements of Husbandry.

*Implements employed in the Practice of Husbandry—Circumstances to be attended to in the Construction of them.—*PLOUGHS*—Different Kinds necessary for different Soils and Situations.—*SWING-PLOUGHS*—Variety of—Capable of extensive Application—Peculiarities in their Construction—The Advantages of which—The Rotheram Plough—Small's Chain-Plough—Ploughs suitable for light friable Soils—Expence of them—Dutch Plough—Suffolk Iron Swing-Plough—Advantages of on strong cohesive Land.—*WHEEL-PLOUGHS*—Construction, various, according to Soil, &c.—Less Skill in the Ploughman necessary for them—Reason of Wheels being added to Ploughs—Uses of them—Friction of them causes Resistance—Mr. Middleton's Opinion of them—Objections to them—Should seldom be employed by good Ploughmen—Sorts of Soil most proper for—Hertfordshire Wheel-Plough—Kentish Turnwrist-Plough—Norfolk Wheel-Plough—Improved common Wheel-Plough—Two-wheel-Plough—Wheel-Plough of the Fen Districts—Double or Two-furrows-Plough—Skim-coulter-Ploughs—Trench-Plough—Uses and Advantages of—The Miner—Its Construction and Use—Paring-Plough—Double-mould-board-Plough—Common Draining-Plough—Mole-Plough—Draining-furrow-Plough—-Marking-Plough—-Single-hoe-Plough.—-*DRILL MACHINES*—-Construction of them various—Principles on which they should be made—Circumstances to be regarded in choosing them—Mr. Amos's Drill—Mr. Cook's Drill—Mr. Ducket's Method more simple—Mr. Mellard's Drill—Advantages and Uses of—Expence of—Mr. Bayley's Turnip Drill—Its Uses on One-bout Ridges—Construction of—His Drill for all Sorts of Grain—Construction of it—Bean Drill for wide Intervals.—Its Form and Make—Drill Barrow—The Uses of—The Extirpator—The Uses and Construction of—Utility of, to be shewn by further Trials.—*HOES*—Difference of—Cook's improved Horse-Hoe—Amos's expanding Horse-Hoe more advantageous—On what Soils most useful—M'Dougal's Hoe—Purpose to which it may be applied—Improvement in the Wheel of—Hoeing may be well done by the common Plough—Experienced Farmer, his Opinion of the Use of the Plough in this Way—*SCUFFLERS and SCARRIFIERS*—More generally employed—The Method of employing them—Purposes to which they are adapted—Construction of them—Mr. Cook's, &c.—Experienced Farmer's Remarks on them—The Instrument he uses described—Uses of Scarrifiers and Scufflers in general—Objections to which they are liable—Not in common so effectual as the Plough.—*DRAGS*—General Construction of—Uses of—Common Drag—Duck-footed-Drag in some Cases more useful—Way in which the Teeth should be put in.—HARROWS—Little Improvement of—To be adapted to particular Uses and the Nature of the Soils—*

*Kind of Teeth most proper —Inconveniences of Harrows in general—How remedied—Harrows with running Bulls—Construction of Harrows—Brake-Harrow—Double-Harrow—Common improved Harrow—Mr. Graburn's Harrow—Uses of—Mr. Knight's Harrow—Advantages of—Harrows proper for Grass Seeds—Bush-Harrow—Mode of Harrowing.—*ROLLERS*—Construction of—Common Roller—Spike-Roller—Drill-Roller—Proper Size of Rollers.—*THRASHING MACHINES*—Principles of—Improvements of—Objections to—How obviated · Circumstances on which their good Thrashing depends—Circumstances to be attended to in using them—Additions that may be made to them—Mr. Middleton's Opinion on the Use of them—Their Advantages over the Flail.—*WINNOWING MACHINES*—Different Kinds of—Cors's and Rogers's on good Plans.—*CHAFF-CUTTERS*—Different Constructions of—In general too expensive—Cook's Nailors—Improvement in one made by the Successors of Winlow.—*RAKES*—Generally well known—Spring-teeth-Rakes—Stubble-Rakes—Twitch-Rakes—Mode of constructing them.—*WHEEL-CARRIAGES*—Circumstances to be attended to in their Construction—Waggons for Husbandry—Faulty Construction of the Berkshire—Improvement of suggested—In general disadvantagous for the Purposes of the Farmer.—*IRISH CAR*—Uses and Advantages of.—*CARTS*—Single-horse-Carts most useful—Observations on the Advantages of One-horse-Carts—Close-Cart, Description of—General Construction of—Coup-Cart—Drag-Cart—Corn-Cart—Hay-Cart—Farmer's-Cart—Quarry-Cart—Remarks on Carts in general.*

THERE is scarcely any part of the extensive and important science of agriculture that has received greater improvements within these few years, than that which relates to the construction of the implements which are necessary to be employed. Since a taste for the art has fortunately been diffused through the country, and men of great knowledge and fortune have been induced to engage in it, persons of ingenuity and mechanical talents have been brought forward and sufficiently encouraged to exert themselves either in the improvement of the better kinds of the old instruments, or in the invention of new ones, by which means more convenient and useful instruments and machines have been provided for almost all the various operations and processes that are continually to be performed in cultivating land, and managing the different kinds of business necessarily connected with it. Among the variety of different implements which have been thus presented to the attention of the agriculturist, some, as may easily be conceived, have appeared, that are evidently much too expensive and complicated in their construction for the purposes which they are intended to serve, and others, probably from a want of practical information in the inventors, have not been properly adapted to the uses for which they were designed; but in general they have been such as have contributed much to the present very improved state of the art.

The backwardness that may be observed, and which is so much complained of in some particular districts in respect to the state of their cultivation, would seem to depend, in some measure, on an attachment to such implements as they have been in the habit

of employing, however imperfect they may be, in preference to such as have been recently invented or improved. This, in some cases too, may probably arise from the want of capacity in the farming labourer to make use of new tools with ease and convenience to himself; and in others from farmers themselves being frequently unacquainted with the instrumental improvements that have been made, or not sufficiently convinced of the advantages that may result from the use of them.

In the construction of every sort of tool for the purposes of farming, as the chief objects ought to be the rendering the business of husbandry more complete, easy, and expeditious, and the introduction of a system of economy in respect to the labour that necessa ily attends it, great care should be taken that they be well adapted to the purpose for which they are intended, and not unnecessarily heavy, while they possess sufficient strength and firmness for the various uses to which they may be applied. It is well observed in an ingenious and interesting periodical publication, that there are no sort of implements that admit of greater improvement than those of husbandry, on the principle of diminishing weight without in any degree abating strength. "Every man knows," says the author, "that if a beam of any length be made of equal thickness throughout its whole length, and a weight sufficient laid upon it, it will inevitably break in the middle, and never at either of the ends; yet, unless it be in the poles of a sedan chair, he can scarcely recollect an instance in which weight has been diminished upon this principle. On the contrary, it is not at all unusual, in the construction of such implements, to see the thickness diminished nearly one half at the very weakest place by means of a mortise cut out in it there, while its thickness in other places is four times greater than would enable it to bear an equal burden. No attention is paid to placing the wood in that position wherein it would be best able to resist the pressure to which it must necessarily be subjected; although it is very well known, that the same quantity of materials may be made to bear in one position above *ten* times as much as it could do in another. It is well known, that mortises weaken the wood to an astonishing degree when injudiciously placed; yet it is no uncommon thing to see two cross-mortises, each of them of twice the size that in any case could have been necessary, made through a beam perhaps at the very weakest parts of it, just as accident may direct, without even an attempt to vary their position, far less to avoid them entirely, which in many cases might be done without the least inconvenience. It is well known that a small brace, judiciously applied, may greatly augment the strength without adding to the weight of an implement; yet contrivances of this kind, which are obvious to the merest tyro in mechanics, seem to be totally disregarded; far less do the constructors of such tools think of adopting new devices of this sort, which a very moderate degree of ingenuity might easily suggest. The importance of having every part firm and compact,

in an implement that is ſubjected to jolts and ſhaking, is univerſally recogniſed; yet, from the moſt trifling conſiderations, we ſee this principle departed from, and loads of ſuperfluous materials added, in vain, to ſupply the defects that are thus produced." He concludes by obſerving, that "it is not to one implement only that theſe obſervations apply, but to almoſt every common implement of agriculture *."

The above principles, though extremely plain and obvious in themſelves, are circumſtances which ſeem indeed to have been greatly overlooked by the practical farmer, and too little regarded by thoſe who have been principally employed in making inſtruments of this nature; as in almoſt every diſtrict of the kingdom, notwithſtanding the many uſeful inventions and improvements which have lately been made, we may ſtill meet with different ſorts of implements that are not only exceedingly awkward and inconvenient from their clumſineſs, but which are uſed with much diſadvantage, on account of their great weight: ſituation, and ſome other cauſes, will, however, render a difference in regard to ſtrength, and other circumſtances, neceſſary, and by them the operator muſt frequently be guided in the conſtruction of tools for the purpoſes of huſbandry. As moſt of the implements of this kind are made uſe of by perſons who have but little knowledge of the nature, power, or action of machines, and as they ſhould be generally in the hands of farmers, they ought always to be conſtructed upon the moſt plain and ſimple principles, of ſuch kinds of materials, and in ſuch ways, as that they may be afforded at a cheap rate, nothing having operated more unfavourably to the introduction of new implements among this claſs of men, than the great expence that attends the procuring of them.

PLOUGHS.

As ploughing, like many other operations in practical huſbandry, muſt often vary in the manner of its being performed, it is evident that no one particular ſort of plough can be ſuperior to all others, in every ſeaſon, and under every variety of ſoil, or inclination of ſurface; different ſoils, ſituations, and uſes, will of courſe require different kinds of ploughs, though there are, undoubtedly, ſome that are capable of a much more general application than others. It has, indeed, been obſerved by the author of a late work on huſbandry, that "the plough which coſts the leaſt money, is the lighteſt to trail, and makes the beſt work, is of moſt value;" which, in general, we believe, may be true †.

In the forming or conſtructing of all ſorts of implements of this kind, there are a few general principles that ought invariably to be attended to; ſuch as the giving the *throat* and *breaſt*, or that part which enters, perforates,

* Anderſon's Recreations in Agriculture, &c. † The Experienced Farmer.

and breaks up the ground, that sort of clean, tapering, sharpened form that affords the least resistance in passing through the land; and to the *mould-board* that kind of hollowed out and twisted form which not only tends to lessen friction, but also to contribute greatly to the perfect turning over of the furrow-slice. The beam and muzzle should likewise be so contrived, as that the moving power or team may be attached in the most advantageous *line of draught*. This is particularly necessary where a number of animals are employed together, in order that the draught of the whole may coincide.

Swing-Ploughs.—As this sort of plough is not incumbered with wheels, it must be the most free from friction, and the resistance which necessarily proceeds from that cause; consequently may, in general, be said to be the lightest of draught.

In the construction of ploughs of this kind there is, however, considerable variation in different districts; but when they are made of proper kinds of materials, and in the most improved manner, they must be allowed to be instruments of extensive application and utility. As besides being effective in their operations, they are not so easily put out of order as other kinds of ploughs; and, from the circumstance just noticed, require in almost every kind of soil, when managed by a good ploughman, much less strength to draw them than those of a similar kind when constructed with wheels; consequently give considerably less fatigue to the horses, or teams of any kind, that may be employed in drawing them. In the mould-boards of most of the improved ploughs of this kind, there is that peculiar form of curvature which lessens resistance in turning up the ground, and which contributes to render the earth of the furrow equally and well laid over to its situation.

The *rotheram-plough*, *Small's chain-plough*, and a *plough* recommended by the Board of Agriculture, as well as several others to be met with in almost every arable county of the kingdom, are formed in this way.

Light thin soils, with little tenacity of surface, such as are commonly employed in the growth of turnips, may be well managed by almost any of the ploughs that are in general use; but as the chief excellence of a plough for this sort of soil would seem to be that of its possessing light weight, easy draught, and being capable of leaving the surface in any desired shape in respect to height of ridge, those of the light swing kind ought certainly to be preferred. Ploughs of this sort have for some time been much employed in most of the northern counties, and in the southern districts are now much more frequently met with. In many places they do not cost more than forty or fifty shillings. That sort of plough which is commonly known by the name of *Dutch plough*, is a light swing-

plough, which, from its not requiring great ſtrength to draw it, may frequently be uſed with advantage on ſome of the lighter ſorts of ſoil, which are pretty free from ſtones and other obſtructing matters of that nature. But where the land is of a ſtrong, heavy, coheſive quality, and where the roots of vegetables, or other ſubſtances, afford conſiderable reſiſtance and obſtruction, a much ſtronger plough muſt be employed. Here the *Suffolk iron ſwing-plough* will, probably, be found a much better, as well as a very neceſſary and uſeful inſtrument, eſpecially when managed by a judicious ploughman. The advantage of this inſtrument has been particularly ſhewn in breaking up ſome of the ſtrong heavy lands of the King's farms in the great park near Windſor. It not only does its work well, but with greater facility than many other kinds of ploughs which are frequently employed on theſe kinds of ſoil. The part to which the team is attached in this ſort of plough is an excellent contrivance for the purpoſe which it is to ſerve *.

Wheel-Ploughs.—The manner of conſtructing theſe ploughs, like thoſe of the ſwing kind, varies conſiderably in different places, according to the nature of ſoils and other circumſtances; but in every form, and in all ſituations, they probably require leſs ſkill in the ploughman. Wheels ſeem, indeed, to have formed an addition to ploughs, in conſequence of the want of experience in this claſs of men; and in all ſorts of ſoil, but more particularly in thoſe which are of a ſtony and ſtubborn quality, they afford great aſſiſtance to ſuch ploughmen, enabling them to perform their work with greater regularity in reſpect to depth, and with much more neatneſs in regard to equality of ſurface. From the friction cauſed by the wheels they, however, give much greater reſiſtance, and conſequently demand more ſtrength in the team that is employed; and, beſides, are more expenſive in their conſtruction, and more liable to be put out of order, as well as more apt to be diſturbed in their progreſs by clods, ſtones, and other inequalities that may be on the ſurface of the ground, than thoſe of the ſwing kind.

It is alſo obſerved by a late ingenious writer, who ſeems to have paid much attention to the invention and improvement of implements for the purpoſes of huſbandry, " that with *wheel*-ploughs workmen are apt to ſet the points of their ſhares too low, ſo as by their inclined direction to occaſion a heavy preſſure on the wheel, which muſt proceed horizontally;" the effect of this ſtruggle, he conceives, to be an increaſed weight of draught, infinitely beyond what could be ſuppoſed: for which reaſon, he thinks the wheel is to be conſidered as of no importance *in ſetting a plough for work*; but paſſing lightly over the ſurface, it will be of material aid in breaking old leys, or ground where flints, rocks, or roots of trees occur,

* Young's View of the Agriculture of Suffolk.

and in correcting the depreſſion of the ſhares from any ſudden obſtruction, as well as in bringing it quickly into work again, when thrown out towards the ſurface*.

But an able writer, in ſpeaking of the agriculture of Middleſex, though by no means an advocate for wheel-ploughs, remarks, that "on a comparative view of the whole of any two extenſive diſtricts, whereof one is tilled with wheel-ploughs, and the other by ſwing ones, as Berkſhire and Norfolk againſt Middleſex and Surrey, including every deſcription of ploughmen uſually met with in thoſe counties, it has appeared to him, on many occaſions, that for neatneſs of work wheel-ploughs have the advantage. This circumſtance, and keeping the men in good temper, is, he thinks, probably of more conſequence than a little diſparagement in point of draught†."

Notwithſtanding this, the objections which we have juſt mentioned, the weight of the carriages for the wheels, and the trouble of fixing and moving them, are inconveniences that operate ſtrongly againſt the uſe of this kind of plough in all caſes, but more particularly in thoſe of general tillage.

An intelligent farmer in one of the midland diſtricts, however, aſſures us, that the rotheram-plough, with one or ſometimes two wheels fixed near to the end of the beam, without any carriage, goes very light, and is very uſeful; ſuch alterations as are neceſſary requiring very little time or trouble. Where two wheels are employed, the plough does very well without a holder on a good tilth or light ſward, except at the ſetting in and turning out.

Wheel-ploughs ſhould, however, probably be ſeldom had recourſe to by the experienced ploughman, though they may be more convenient and more manageable for thoſe who are not perfectly informed in that important and uſeful art.

This ſort of plough will, in general, be found moſt ſuitable for the more ſtiff tenacious ſoils, and thoſe in which ſtones, flints, or other obſtacles of the ſame kind abound, the moſt advantageous and deſirable properties under ſuch circumſtances being thoſe of ſtrength, and of not being eaſily thrown out of the ground. For general purpoſes in ſuch ſoils, perhaps the *Hertfordſhire wheel-plough*, which has a piked ſhare, may be the moſt ſuitable implement; but where the ground is very ſtrong, and where very deep ploughing is required, the *Kentiſh turnwriſt-plough*, with a chiſel-pointed ſhare, ſhould probably be preferred.

On light, loamy, and friable ſoils, where deep ploughing is not neceſſary, the *Norfolk wheel-plough* will be found a convenient and uſeful tool, as being compact and light in its form, doing its work with neatneſs, and requiring only a ſmall draught.

* See Communications to the Board of Agriculture, vol. II. p. 419.

† Middleton's View of the Agriculture of Middleſex.

The rotheram-plough, with a wheel as above, might probably, in many caſes, be made uſe of with equal, if not greater advantage, from its being very light and requiring little ſtrength in the team.

The improved *common wheel-plough*, and likewiſe the *two-wheel-plough*, are implements which will be found uſeful in certain kinds of ſoil where the more complex ones cannot be employed, as in breaking up freſh grounds, &c. The former has been lately much improved by the addition of an iron earth-board firmly ſcrewed to the coulter, which in ſome places is called a *flay*. It is made uſe of when ploughing turf, by which it is taken off and turned into the furrow, when the plough immediately covers it with earth. It is obſerved that, by this management, turf, at one ploughing, has the appearance of a fallow, and harrows nearly as well. A little more ſtrength in the team is however required *.

The latter has generally a check-chain, by which the wheel is pulled up, in order to be out of the way in opening ridges and clearing up furrows. There is alſo in ſome of the fen diſtricts a kind of *wheel-plough*, which has much reſemblance to the Dutch paring-plough employed in Cambridgeſhire, which is a good inſtrument for ploughing where there is much ſtubble, or where the want of proper management in the farmer has ſuffered twitch-graſs to become abundant. The mould-board in this plough has a good ſweep, and the ſhare a proper form, which ſhould be conſtantly kept ſharp by means of files, and be well ſteeled. The coulter in this ſort of plough is a ſteel wheel, which is well adapted for the purpoſes we have juſt mentioned. Mr. Young, in his account of the agriculture of Lincolnſhire, remarks, that Mr. Cartwright affixes to this plough a bean-drill of great ſimplicity, that drills upon the centre of the preceding furrow, while the next is turning; with which apparatus it muſt be a very convenient and uſeful implement for a variety of purpoſes in arable huſbandry.

The *double* or *two-furrow plough* is an implement that has not yet, perhaps, been fully tried in different kinds of ſoil; but which certainly, when well made, may, in many ſorts of land, be advantageouſly employed. It produces two furrows at once, and in ſome of the lighter ſorts of ſoil has been found to perform its work in a tolerably neat manner. It requires, however, great power in the draught, eſpecially in ſtrong ſoils when dry and ſtony, and does not even in ſome caſes anſwer well. But for ploughing level ſandy lands into wide ridges it may, in general, be a good tool, though it is obviouſly more confined in its work than a ſingle plough. The chief and moſt important advantages attending its uſe are, in the ſaving of the attendance of one perſon, and in doing nearly double the work in the ſame length of time, with

* Pitt's View of the Agriculture of Staffordſhire.

but little more ſtrength in the team. Ploughs of this kind are made either with or without wheels. It is, however, obſerved by the inventor or improver of them, that thoſe which he has contrived, from the clean ſharpened conſtruction of the breaſt and throat, will be enabled to break up deep ſtiff land with infinite ſucceſs; in which caſe, the coulters ſhould, he ſays, be ſet nearly ſtraight with the throat and ſhares; but that in croſs-ploughing or ſtirring, they may be ſet three-fourths of an inch towards the land, by which greater diſpatch may be obtained in ſeed time. Should they carry too deep a furrow, the correction of their ſhares, he obſerves, is obvious; but if they hug too much to the land, or go unſteady to the ploughman, it muſt proceed from a want of ſetting them true, relatively to each other, and from an undue regulation of the cops, as in this a nice attention is required. It may ſuggeſt itſelf, he further remarks, that two-furrow-ploughs are unfit for hilly ground; but he thinks the very reverſe is the caſe. The effect, he ſays, of ploughing acroſs the inclined plain or hill, is that of carrying the ſoil in time to the bottom of the field, which muſt be carried bodily up again at a great expence: let ſuch land, ſays he, be therefore worked from top to bottom; one furrow being carried with the hindmoſt or land ſhare up the hill, and two down, ſo that the power may be apportioned to the weight with which it has to contend, and the needleſs toil to the team be ſaved. That power which was required to carry two furrows up, would be ſuperfluous in carrying the ſame down the hill; and the effect will be as three to four, or an acre and a half inſtead of two acres in a day. And as deep ploughing is not much required, except where the cultivation of tap-rooted plants are intended, he thinks that two-furrow-ploughs, though they ſhould be deemed incapable of carrying a deep furrow, which, he contends, is far from the truth, muſt come into admirable effect, as a twofold advantage can be taken of the ſeaſon in ſowing, and the buſineſs being done at half the expence. But where long uſage, and the convenience of conſtant road, confine perſons to teams of heavy corn-eating cart-horſes, theſe ploughs become objects of great importance; becauſe their teams will not, he conceives, feel the difference between their common ſingle-furrow working one acre, and the well-conſtructed two-furrow plough with two acres a-day. It is remarked in addition to this, that ſome of the midland counties, as Leiceſter and Stafford, have been greatly benefited, under theſe circumſtances, by the uſe of theſe ploughs, although they have not been ſo conſtructed in the throat and breaſt as to leſſen the means of reſiſtance. And obtuſity in theſe parts not only adds incalculably to the weight, but is liable to break the furrow, and thus ſpoil the work. It may likewiſe be obſerved, that removing reſiſtance, not only removes the labour

of the cattle, but is equally advantageous in increaſing the ſtrength of the implement.

It is ſtill further remarked, that this ſort of plough has lately been found uſeful in his own country, in even breaking up ley-ground, although formerly only in common uſe for fallowing, not being thought capable of ploughing leys, as, from their conſtruction, requiring too great ſtrength in the team; and that a premium has lately been given for this ſort of plough, working ley-ground only. He ſtates alſo, that one acre and an half of ley-ground was broken up by four oxen with great eaſe to themſelves in three hours and fifty-five minutes, they having, as part of a conſtant courſe of work, ploughed ſeventeen perches ſhort of an acre of the ſame kind of ground the ſame morning: this was performed in order, he ſays, *to prove the effect of moveable plates at the extremities of the mould-board*, that the furrows might be laid more or leſs flat; as mould-boards formed to lay furrows in ley, ſo as to give the greateſt quantity of mould or ſoil to harrows, cannot be of that ſhape or form beſt ſuited to make good work in ſtirring earths, more eſpecially the laſt, which ought to be thrown up in ſmall ſeams, as it were, that the ſeed may be properly buried. For this purpoſe it has, he aſſerts, hitherto been uſual to rip off the plate and drive in wedges, by which the mould-plate muſt be liable to be injured; and from the trouble attending the operation, it has often been omitted, and conſequently the land imperfectly worked. This inconvenience may, he ſays, be remedied, and the mould-board be adjuſted with great facility and expedition, by having the neceſſary parts of the mould-board or plate cut off, and afterwards connected with the fixed parts of it by means of flat hinges, or of thin flexible plates of tempered ſteel, or of hard hammered iron, ſo as to admit of theſe parts being ſet to have different inclinations with the fixed part of the mould-board. By means of two ſcrews paſſing from the inſide through the lower parts of the handle of the plough, oppoſite the back parts of theſe moveable pieces, they may be kept at any deſired degree of inclination according to the nature of the work to be performed. As ley-grounds cannot be laid too flat, or ſeed earths too much on an edge, by this improvement in the mould-board of theſe ploughs he thinks it may be readily adjuſted for either purpoſe, as it may be rendered more flat or more convex, according to the circumſtances of the caſe. That part of the mould-plate the moſt liable to wear ſhould be made of double the thickneſs of the others, in order to render it as durable as the reſt of the plough.

The increaſed weight of draught when theſe moveable plates were extended, did not appear, he obſerves, on trial, in a two-furrow-plough, to be, by the cops, more than twelve pounds, in ley-ground at ſix inches depth. The friction in fur-

rows required to be laid flat, was, it is ſaid, leſs than could have been ſuppoſed; probably in both furrows not more than from twelve to ſix pounds*.

It is remarked by the ſame author, in another work, that in order to qualify ploughs of this kind for broad work of every deſcription, breaking up of leys not excepted, theſe plates are abſolutely requiſite; and that in ſingle ploughs they are almoſt equally ſo. The principle of this moveable plate, ſays he, though it may not at firſt catch the attention of every one, has found ſtout advocates in ploughmen, as it ſaves their right arm much trouble in wedging and hammering mould-plates, and their right leg much exertion in attempting to tread flat the furrow which the plough had left on an edge†.

But, notwithſtanding theſe ingenious and intereſting obſervations, from the nature and conſtruction of ſuch ploughs, they muſt obviouſly be much more limited in their application than ſuch as are ſingle; and under ſome circumſtances, as where the land is full of ſtones and uneven, perhaps wholly inapplicable.

Where, however, the circumſtances of the land are ſuch that they can be introduced with any probability of advantage, they ought not to be overlooked, as being conducive, by their great diſpatch of work, to economy in farming labour, which is certainly an object of much importance.

Skim-Coulter-Ploughs are a ſort of ploughs that may often be employed with advantage on extenſive farms, where there are ſuch kinds of lands as require them. Of theſe ploughs there are many different ones adapted to particular uſes and ſituations; ſuch as the *Trench-Plough*, which is ſo contrived as to turn up the ground to a great depth, in ſoils of different kinds, where there is ſufficient ſtaple. It is an exceedingly uſeful implement in various caſes, as, by means of it, land may be opened to any depth in ſeparate horizontal ſlices, the weeds being thus cut off in the firſt operation, while the next raiſes a ſlice or portion of freſh mould from below the ſoil which afforded the former crop, and depoſits it upon the rubbiſh before turned down, by which means more abundant nouriſhment is prepared for the crop that is to follow. For theſe purpoſes, however, in all ſoils, a ſtrong team muſt be had; but only one ſuch tillage is required for moſt crops. From the ſlices of earth raiſed by this plough, being placed one over another, the ground generally harrows well, and the growth of weeds is in a great meaſure prevented. It is conſequently evident, that, conſidering the number of ploughings generally given in the ordinary way of preparing lands for

* Communications to the Board of Agriculture, vol. ii.

† Somerville's Syſtem of the Board of Agriculture.

a crop of barley or turnips, and under the following ſyſtem for wheat, and the labour and expence in the latter caſe, of raking, picking, and burning weeds, that the advantages of the trench-plough muſt be greater than is, perhaps, generally ſuppoſed. There is alſo another conſideration of ſome importance in this ſyſtem of management, which is, that the ſtaple of the ſoil is increaſed in depth, and its parts ſo divided and looſened, that the fibres of the roots of the crop are more at liberty to range, and of courſe to take up their proper nouriſhment, which muſt render it more certain and of better quality. A plough of this kind, with a double ſhare, one placed directly over the other, has been much employed by ſome good cultivators in the ſouthern parts of the kingdom. By this means, one narrow ſhallow furrow may be taken off the ſurface, and another beneath it any moderate depth that may be required; and it will perform its buſineſs to ten inches in depth, as well as only five or ſix. It is an highly uſeful tool in putting in one crop immediately after another; a mode of cultivation which could not indeed be well practiſed without it. In this way rye, or other green crops, which have great height of ſtem, may be turned down without leaving any part of them ſticking out in the ſeams or crevices between the furrows; whatever is turned in being really covered, by which means the ſurface is of courſe perfectly free from weeds, and clean for the ſucceeding crop of whatever kind it may be*.

The *Miner* is another plough, which is uſed for opening ground to a great depth; it is made very ſtrong, but with a ſhare only, not having any mould-board; it therefore rather looſens than turns up the earth. In deep ſtiff ſoils, where the ſurface mould is good, it may be conveniently employed in the ſame furrow after a common plough, in order to ſtir the ground to a greater depth. It is in uſe in ſome of the northern counties; and Doctor Anderſon mentions it as an implement that all farmers who have land ſuitable for it ſhould have in their poſſeſſion. It is an extremely uſeful tool where working deep is neceſſary without bringing up the inert under ſtratum or ſub-ſoil, as in looſening the ground for carrots, or other tap-rooted plants, and in eradicating the roots of thiſtles or other weeds which ſtrike deep in the earth.

The *Paring-Plough* is a neceſſary inſtrument where the practice of paring and burning is much required, as in bringing into cultivation heath, moor, and other waſte lands. It is conſtructed in ſuch a manner that the ſurface of the ground can be cut off to any depth, which is an advantage that can ſcarcely be obtained by any other means.

* Annals of Agriculture, vol. x. p. 190.

The *Double Mould-Board-Plough* is a kind of plough that may ſometimes be employed with advantage in making furrows, and ſetting potatoes, cabbages, and other ſimilar crops, and in earthing up thoſe and other vegatables that are planted in rows. The ſame purpoſe may, however, frequently be anſwered by a plough of a leſs expenſive and leſs complex kind.

In the ſurface-draining of land, different ſorts of ploughs are in uſe in different places, according to the difference of the ſoils, and the objects of the farmer.

The *Common Draining-Plough*, which is employed in ſome of the midland counties, for the more general purpoſes, is a good, and not very expenſive, tool. And the *Mole-Plough*, invented by Mr. Adam Scott, and as improved and made uſe of in the midland counties, is likewiſe an implement of this kind, which, in ſuitable ſoils and ſituations, as in pleaſure-grounds, and where much regard is had to the ſurface-appearance of the land, may be of conſiderable benefit in forming temporary drains. It makes a drain without opening the ſurface any more than merely for the paſſage of a thin coulter, the mark of which ſoon diſappears. This inſtrument is chiefly employed in ſuch graſs-lands as have a declination of ſurface, and where there are not many obſtructions to contend with; but it may be uſed in other kinds of land, as on turnip-grounds that are too wet for the ſheep to feed them off, or where on account of the wetneſs the ſeed cannot be put into the earth. With this plough the drains ſhould be made at the diſtance of ten or fifteen feet in ſtraight lines, and all ſo contrived as to diſcharge themſelves into one large open furrow, or grip, at the bottom of the field. As it requires great ſtrength to draw this implement, it can only be uſed where a good team is kept. It is ſuggeſted by a very intelligent practical agricultor, that in deep clayey ſoils it may be highly uſeful, but that where there are beds of gravel or ſand intervening, it cannot be employed with advantage.

The *Draining-Furrow-Plough* is another plough of this claſs, which may be employed for making large open furrows, by which the water may be taken off from the ſurface of the land. It will frequently be found a neceſſary tool in thoſe clayey ſoils where water ſtagnates on the ſurface of the ground, and which cannot be removed by the more general modes of under-draining.

The *Marking-Plough* is an uſeful inſtrument for the purpoſe of ſtraightening, as well as regulating the diſtance of ridges, where the practice of drilling is in uſe.

The *Single Hoe-Plough* is likewiſe an implement which, from the great ſimplicity of its conſtruction, may be of much utility in ſtirring the mould in the intervals of grain, or other crops, and laying it to the roots of the plants, thereby deſtroying and preventing the growth of weeds. The mould-board in this plough is ſo contrived that

it can be raiſed or depreſſed according to the nature of the crop, and the intention with which it is employed.

Drill-Machines.

In the conſtruction of all implements of this ſort the greateſt attention ſhould be paid to have them as ſimple in their mechaniſm as poſſible, in order that they may be uſed without difficulty, by thoſe who have but little knowledge of the nature of ſuch machinery: much care ſhould alſo be taken to have them ſo made, as that they may perform their work with correctneſs; that the ſeeds, of whatever kind, may be delivered and depoſited in the ground with the greateſt evenneſs and regularity; and that they may not be bruiſed or injured in any way during the operation; as the want of proper attention to theſe particulars ſeems to have conſiderably retarded the progreſs of the drill ſyſtem of cultivation.

Various implements of this ſort are in uſe in different parts of the iſland, which are contrived for the purpoſe of ſtirring the earth, and drilling different kinds of grain and ſeeds at the ſame time; but in the choice of ſuch tools the farmer ſhould be chiefly directed by the ſituation of his ground, the nature of the ſoil, and the kinds of grain which he intends to cultivate. In general, however, the more ſimple the conſtruction of ſuch inſtruments, the better they perform their work: one and the ſame ſort of drill cannot, however, anſwer on farms of large and ſmall extent; they ſhould, therefore, be adapted to the ſize of the farm, as well as the nature of the ſoil and crop that is to be cultivated.

The machine which was propoſed and made uſe of by the ingenious and intelligent improver of the drill huſbandry, ſeems to have been by no means well adapted to the purpoſes of the ſyſtem, and on that account probably contributed to retard the progreſs of the art. It neither ſew the ſeed in ſufficient quantity, or with ſufficient accuracy, though its general principle appears to have been ſufficiently clear and ſimple, from its having become the model of many ſubſequent implements of the ſame kind. A late ingenious author has recommended many intereſting and uſeful improvements in this machine, ſuch as enlarging that part of the axle-tree which delivers the grain into a cylinder of ſome inches in diameter, with excavations in the rim, which rim riſes above the corn in the ſeed-box, and lets drop again into the ſeed-box whatever grains fill the holes above the level of the rim, as that ſide of the cylinder aſcends. By theſe ingenious contrivances the quantity of ſeed delivered is rendered uniform, and none of the grain is in the way of being cruſhed or otherwiſe injured. The whole machine thus becomes ſimple in its conſtruction, and of no great expence, which are circumſtances of the greateſt importance in ſuch machines.

The great simplicity of this improved machine consists, the author observes, first, in its having only a seed-box, and not both a hopper and seed-box as in some others, as that of Mr. Cook; secondly, in the flues which conduct the seed from the bottom of the seed-box into the drill-furrows not being disjoined in the middle, in order to permit the lower part to move to the right or the left, when the horse deviates from the line in which the coulters pass, as in Mr. Cook's machine, which in this is performed by a simple universal joint; thirdly, in the horns or shafts behind, between which the person goes who regulates the coulters, being equally fixed to the coulter-beam and the axle-tree, while in others, as that we have just mentioned, they are all of them moveable joints, like a parallel rule for the purpose of counteracting the swerving of the horse, which is here done by a simple universal joint; fourthly, in altering the dimensions of the holes in the axis of the seed-box, by simply turning a screw, so as to adapt them to all kinds of seeds which are usually sown on field lands; fifthly, in the strong brush of bristles which sweep over the excavations of the cylinders beneath the seed-box, strickling them with such exactness that no supernumerary seeds escape, and that none of them be the least broken or injured, which is the case in other machines, as the original one of Mr. Tull; and lastly, in its greater simplicity rendering it less expensive in its construction, and less liable to be out of repair, as well as the management of it more readily and more easily understood*.

In the same ingenious and philosophical work the author also describes a seed-box, the invention of Mr. Swanwick, of Derby, by which the seed may be deposited with still greater accuracy. This box is forty-eight inches long within; which space is divided into six cells, for the purpose of sowing six rows of seed at the same time, as in that just described; and at the bottom of each is a hole for the seed to pass through into the seed-flues, but without any revolving axis, a wooden bar about four feet eight inches long, and three-eighths of an inch in thickness, through which there are six perforations, each of them exactly one inch long, and half an inch wide, and three-eighths of an inch deep, which is the thickness of the bar that supplies its place. The centres of these holes are exactly eight inches distant from each other, correspondent to the holes at the bottom of the seed-box, over which it is made to slide backwards and forwards in a groove. In this sliding motion it passes under stiff brushes, which are placed over it on each end of the holes, at the bottom of the seed-box, and strickle off the grain as the holes in the sliding bar pass under them, by which the quantity of seed is measured out with a considerable de-

* Phytologia, p. 608.

gree of accuracy. And in order to increaſe or diminiſh the quantity of grain delivered, the ſlider is covered with a caſe of tin, which has ſix perforations, exactly correſponding with the holes in the ſlider; but inſtead of the bit of tin being cut out the whole length of the hole, part of it is left at one end equal to the thickneſs of the ſlider, and is bent down after the ſlider is put into the caſe, in the ſame manner as the tin cylinder in the above machine. This caſe is moveable about an inch backwards and forwards by turning the finger-ſcrew, and thus the holes are made larger or ſmaller in order to ſuit various ſorts of grain, or different quantities of the ſame ſort. The ſlider is moved forwards by a bent iron pin which is attached to it, and which paſſes into a ſerpentine groove fixed to the nave of the wheel, and backwards by a ſteel ſpring at the other end of the ſeed-box. It is obſerved that the ſimplicity of the ſlider at the bottom of the ſeed-box in this inſtrument may be, in ſome reſpects, greater than that of the wooden and tin cylinders in the former one, as this has but ſix holes to meaſure out the ſeed, while the other has twenty-four; but that, perhaps, in other reſpects it is leſs ſo, as in this there are twelve bruſhes, one on each ſide of each of the ſix holes, whereas in the former only ſix bruſhes rub upon the tin cylinder. It is probable too, that as the reciprocating motion of this ſlider muſt be quick, as it muſt act once every time the periphery of the wheel of the carriage has paſſed nine inches forwards, it may not be ſo eaſy to execute as the cog-wheel and uninterrupted movement of the axis and cylinder in the preceding drill*.

A machine of this kind, invented by Mr. Amos, and deſcribed in his treatiſe on drill huſbandry, is ſaid to be a good, cheap, and convenient tool. Grain, ſeeds, and pulſe of all ſorts, are aſſerted to be eaſily ſown by this inſtrument on every deſcription of land, in any quantity, and at ſuch depths and diſtances as may be required. It is conſtructed with ſpherical cups and ſows, at a great variety of different diſtances, both in reſpect to the rows and the intervals, performing its buſineſs with much diſpatch and little ſtrength of draught †. The drill part of the machine may be fixed to the beam of any common plough. There are, however, ſeveral other implements of the ſame kind made by different perſons, which have been found to perform equally well.

Mr. Cook's improved *Drill* is a well-conſtructed inſtrument, and on certain light ſoils is found to anſwer perfectly; but on others it is ſaid to be liable to deliver the grain with ſome inequality. An intelligent agricultor, who has had much experience of it, however, remarks, that it is an implement which will depoſit any

* Phytologia, p. 609. † Amos on Drill Huſbandry.

quantity of ſeed on the acre, at any required depth, with intervals of eight, nine, eleven, or eighteen inches, and at two, three, or four feet width, with conſiderable exactneſs; and that wherever it fails of ſucceſs, he ſuppoſes, it muſt proceed from the want of proper attention in the perſon who makes uſe of it. With him it has been found uſeful upon all ſoils, except ſuch as are ſtony or rocky, and he thinks it may be employed with equal advantage on ſtrong clays and clayey loams, as on thoſe of the lighter kind. This drill is conſtructed ſomewhat on the ſame principle of that which has been juſt mentioned, and is certainly capable of pretty general application. One invented and employed by Mr. Ducket is alſo ſimple in its nature, and likewiſe ſaid to be capable of being managed with great eaſe, by an ordinary workman.

A machine of this kind, which the Kentiſh farmers find very convenient for drilling wheat, barley, oats, peas, tares, and various other crops, is made by Mr. Wellard, of Deal. It is drawn by two horſes a-breaſt in a double pair of ſhafts, and drills ſeven rows at a time, ſeven inches apart. From the peculiarity of its conſtruction, any quantity of grain required per acre can be drilled, and from its great ſimplicity it is not liable to be put out of order. It coſts about fourteen guineas.

Turnip-Drill.—An uſeful inſtrument of this ſort has been contrived by Mr. Bailey, for ſowing turnips on the tops of one-bout ridges. In this implement the defects of ſowing too much or too little ſeed are obviated. It conſiſts of a ſolid cylinder, made of iron or braſs, about two inches in diameter and one inch broad, on the ſurface of which are formed fifteen or ſixteen cavities reſembling the form of a ſemi-egg when cut longitudinally, and as deep as to hold four or five ſeeds each. On the back of the cylinder, a little from the top, is placed the hind part of the hopper, to which is fixed a piece of iron or braſs one inch long and half an inch broad, hollowed on the inſide into the form of a Gothic arch, the ſides of which meeting the ſides of the cavities in an oblique angle, prevent the ſeeds from being bruiſed: at the lower end of this piece of iron, or gatherer, there is a ſlit three-tenths of an inch long and one-tenth wide; and at the back of it, a thin flat piece of iron moves up and down by means of a ſcrew at the top of the hopper, which enlarges or leſſens the orifice directly above the cavities, and increaſes or diminiſhes the quantity of ſeed delivered, as the operator may think proper. This ſlip of iron, or regulator, is let into a groove made in the board which forms the back part of the hopper.

The cylinder is fixed before the cavities are made, on an iron axle one inch ſquare, turned very true, as well as thoſe parts of the axle which turn in the collars fixed in the handles. To the ends of the axle, two wheels, twenty-ſix inches in diameter, are fixed, which turn the axle and cylinder round, and which in

paſſing through the hopper containing the ſeed, bring forward in each cavity a number of ſeeds and drop them into the ſpout, by which means they are conveyed to the coulter, which forms a channel on the top of the one-bout ridge in order to receive them.

If the cavities in this drill be made to hold five ſeeds when the regulator is ſcrewed cloſe down, and there be ſixteen of them, it will depoſit eighty ſeeds each revolution; and from the diameter of the wheel being twenty-ſix inches, and the circumference eighty-one inches and a half, eighty ſeed will be ſown in eighty-one and a half inches, or nearly twelve in a foot. This being the *minimum* quantity, by ſcrewing up the regulator the number may be increaſed gradually to fifty or ſixty in a foot; which is far more than is neceſſary, except in particularly unfavourable ſituations.

Another *Drill* conſtructed by the ſame gentleman for ſowing all kinds of grain, in any quantity, and at any diſtance, ſeems likewiſe to have conſiderable merit. The inſide part of it, by which the quantity of ſeed is regulated, is an iron axle one or one and one-fourth of an inch ſquare, upon which are fixed, at nine or ten inches diſtance, five or ſix or more braſs fluted cylinders, the flutes being rather more than a ſemicircle five-eighths of an inch in diameter, or five-eighths wide and ſix-eighths in depth. To theſe are fitted hollow cylindrical rims of hammered iron, which have ſegments turned down at right angles, to form exactly to the flutes of the braſs cylinders; the cavities of which are increaſed or diminiſhed by the ſegments of the iron cylindrical rims ſliding backwards and forwards in the flutes. This is performed in all the cylinders at the ſame time, by a rectangular ſpace being made in the braſs cylinders, through which paſſes a ſtraight piece of iron moving on friction-wheels, and faſtened to the plates, and alſo the cylindrical rims. A lever moved by a ſcrew paſſes through the frame; one end of which is forked, and made to fit exactly the ſides of the collar or plates of iron. By turning the ſcrew the lever moves the whole of the rims at once, and the cavities are increaſed or diminiſhed at pleaſure, and almoſt inſtantaneouſly, even while the machine is going and at work, ſo as to ſow all ſorts of grain and in any proportion.

When *Turnips* are to be drilled, the large hopper is taken off, and a ſet of ſmall ones fixed upon the half-egg cavities at the end of the braſs cylinders, and the quantity of ſeed regulated as in the turnip-drill juſt deſcribed.

For ſowing beans and peas at wide intervals, as from twenty-ſeven to thirty inches, Mr. Bailey makes uſe of a drill with only one wheel and one cylinder, which a man wheels before him in the furrow: or a method which he finds better, is, to fix it in the body of a ſmall plough drawn by one horſe, with one ſtilt that

paſſes between the wheel and ſeed-box. By this means the wheel moves on a ſmooth ſurface between the land ſide and mould-board, and the ſeed is depoſited at a regular depth. For beans he finds two inches to anſwer very well. By means of the ſame plough he has ſown both wheat and barley at different intervals from ſix to twelves inches, and one and a half or two inches deep, with good ſucceſs; and for ſmall concerns, he thinks that this cheap and ſimple apparatus will be found very eligible and advantageous.

The drill is fixed to the plough by two pieces of iron going from the ends of it, one to the beam and the other to the ſtilt; which moving round on bolts, allow the wheel to fall and riſe with every accidental hollow or eminence. The lower part of the coulter is kneed or bent to bring it to the ſame plane with the land ſide of the plough.

The *Drill-Barrow* is an inſtrument contrived with much ſimplicity, and well adapted for ſowing ſome grains and ſmall ſeeds, as it can be readily regulated in reſpect to the proportion of the ſeed. It, however, ſows only one row at a time, which in many inſtances is inconvenient. This machine would be much improved if it were made to drill ſeveral rows at once, and capable of being regulated in reſpect to diſtances for the ſeed. In ſome places this drill is much eſteemed for putting in bean crops, in doing which it delivers into the furrow.

HOES.

Of this kind of tools there have been a great number invented at different times both for the purpoſe of being drawn by horſes, and uſed with the hand. Mr. Cook's improved horſe-hoe is unqueſtionably a good implement for hoeing crops at certain diſtances; but for narrow irregular diſtances the expanding horſe-hoe, contrived by Mr. Amos, is probably a preferable inſtrument, as its moveable ſhares render it capable of being regulated to different ſpaces, according as the crops may have been drilled with greater or leſs intervals. It will be found moſt uſeful on light friable ſoils, and where the ground is in a mellow condition. This hoe is conſtantly made uſe of by ſome good farmers in Lincolnſhire for beans, cabbages, potatoes, and ſuch-like crops, and found to be very effective *.

M'Daugals's *improved Hoe* is conſtructed on a ſimple principle, and anſwers the various purpoſes of a hand-hoe with great eaſe and convenience, eſpecially where the grain or pulſe has been ſown in equidiſtant intervals. The wheel in this in-

* Young's Survey of Lincolnſhire.

ſtrument ſhould, however, be made ſolid, as the open wheel is liable to clog and fill up when the ground is ſoft and wet.

But in mellow ſoils, and where hand-hoeing is practiſed, the implements of this kind which have been invented by Mr. Ducket are probably more uſeful; as from their being heavier in the iron work, and having ſhorter handles than thoſe in common uſe, they would ſeem to be more effective. Hoes in ſome reſpects ſimilar to theſe have long been in uſe for hoeing the ſtrong land of the vineyards in Portugal *.

But notwithſtanding theſe inſtruments, the buſineſs of hoeing may frequently be well performed on ſtiff ſoils, and where the diſtances of the crops are pretty wide, with any common ſmall plough that has a broad ſharp ſhare. With thoſe inſtruments the workman can go to what depth and as near the rows as he pleaſes. It has been obſerved, and probably with truth, by a late writer, that he can find nothing equal to a "plough for the purpoſe of cleaning land and earthing the crops. He has tried," he ſays, "double-moulded or double-breaſted ploughs to earth up the rows, but that they will not at all do in drill huſbandry, as you cannot humour them to the width of the rows, which are ſometimes a little wider or narrower; and if they vary but an inch or two, it deſtroys the effect intended, as the mould cannot be regularly raiſed, and the corn will be in ſome places high, in ſome low. A common plough will perform this work to perfection; the expence amounts to not more that one ſhilling per acre, and the ſervice rendered the crop is worth a pound at leaſt, excluſive of the advantage of cleaning the land better than by any other means; for when you ſee a weed you may," he ſays, "with a common plough go ſufficiently deep, or give it what direction you pleaſe."

And in ſpeaking of this kind of tools he further remarks, that as ſuch weeds as ſtrike with a tap-root are not eaſily cut by the ſcarifier when it happens to be blunt, but are often dragged down and left growing, he has invented an inſtrument ſuperior to the plough or ſcarifier for the purpoſe. "It is made," he ſays, "of a triangular form, with a beam, and two ſmall wheels under the beam to run before it, in the ſame manner as in the Norfolk plough. There are three coulters, with a ſhare rivetted under each of them, made ſharp at the point like a fleam, and about fourteen inches wide. The coulters penetrate under the mould as deep as the plough, and, without moving the earth much, cut up thiſtle, brackens, &c. better than any inſtrument he has yet met with. Where ſuch weeds are very numerous, he uſes a beam with one wheel, into which he puts one of the coulters, to cut between

* Communications to the Board of Agriculture, vol. II. and Somerville's Syſtem of the Board of Agriculture.

the rows of the drills: it will penetrate any depth required. The one with three ſhares will, with a pair of horſes, do as much work in one day as three ploughs." It is however obſerved, that this machine will work only upon light land where the fallow is well broken and nearly clean of twitch. Where kitlocks grow it will alſo, he thinks, be found very uſeful; and it is of ſuch a ſimple conſtruction that any perſon may make it *.

SCARIFIERS AND *SCUFFLERS.*

THESE are inſtruments which are in a great meaſure ſimilar to that juſt deſcribed, and which ſeem daily to be coming into more general uſe for the purpoſe of clearing and rendering arable land ſuitable for the reception of the ſeed, as well as for ſcarifying and ſtirring the earth between the rows of drilled crops. They are likewiſe ſometimes made uſe of for clearing ſtubble after the crop has been taken off, but for which they are not probably good tools. They are made of various forms and conſtructions, and have commonly a great number of iron plates or feet, the edges of which are well ſteeled and kept ſharp. Theſe are moſtly fixed to the ends of an equal number of iron bars forming a kind of legs. Some of theſe tools are alſo made with wheels, and others without them; the latter ſort anſwer equally well for many uſes, and are much leſs expenſive. A pair of handles are generally fixed on behind, by which the implements are worked, and, by the difference in the degrees of preſſure, are regulated in reſpect to depth at the pleaſure of the perſon who has the management of them. The feet ſhould have a ſort of triangular ſhape, each of the ſides of which may be about ſix inches in length. They ſhould be ſo contrived as to cut up the roots of weeds at a good depth, and not be eaſily thrown out of the ground by ſuch obſtructions as they may occaſionally meet with. They may be uſed with different numbers of tines or teeth, according to the difference of intention with which they are employed, and in proportion as the land is clean or foul, looſe or tenacious. The implements of this kind which are made by Mr. Cook are very good ones; and others, contrived with great ſimplicity, are deſcribed in many of the reports publiſhed by the Board of Agriculture.

The main object of theſe inſtruments is, that of leſſening the uſe of the plough; and in certain ſituations and ſoils they may, without doubt, be employed with more advantage to pulverize the earth and clear the lands from weeds. Lands which have been once ploughed over, in preparation for barley or turnips, may be

* Experienced Farmer, vol. II. p. 86.

eaſily rendered clean and fine by them, and the uſual ſubſequent harrowings and ploughings be made unneceſſary. As the implement of this kind which has been deſcribed above, cannot, as the inventor aſſures us, be employed except where the ground is light, and "where the fallow is well broken, and nearly clean of twitch*," it may be objected to on that account. But there is, beſides this, another objection to this ſort of tools, which is that of their being liable to clog much when the land is wet, an inconvenience which conſiderably leſſens their general application. In the conſtruction of the improved *Scuffler* employed in ſome of the midland diſtricts this inconvenience has however been attended to, and in a great meaſure corrected. The wheels in this inſtrument are made a foot and a half in diameter, and the length of the hoes two feet, having a ſlight curve. It is alſo ſo contrived, that it may be drawn by two horſes abreaſt, or at length, as may be found moſt proper and convenient.

The *Extirpator* is a machine of this ſort which ſeems to be uſed with advantage in ſome parts of Suffolk, as well as other counties, for deſtroying weeds, and clearing ſuch lands as have been once ploughed for the reception of the ſeed. It is drawn by two or more horſes, according as the ſoil is more or leſs heavy and tenacious, and as the depth required is greater or leſs. It does much work in a little time. When employed, it may be fixed to the wheels of a common wheel-plough, and be regulated in reſpect to depth in the ſame manner.

If the land has been once ploughed over and laid a ſummer fallow, the common way of proceeding with this inſtrument is to work it over twice with it; the firſt time about two inches deep, and the ſecond croſſways about four inches in depth; which, by afterwards running a common harrow over it, renders it proper for the drill or ſowing. Lands ploughed in Autumn, and intended for ſpring crops, may alſo be well prepared for the ſeed by this inſtrument.

The ſhares in this tool are commonly made about nine inches long, and nearly of the ſame breadth, being attached to a kind ſtem or ſhank of ten inches in length, at the diſtance of about twelve inches. It has ledges before and behind; the firſt of which is about five and a half inches long, and the latter ſix feet in length, both having the ſquare of four inches: the diſtance of theſe ledges from each other is generally about twelve inches. The beam is ſeven feet in length, having the elevation of about three feet. It has likewiſe two handles behind.

It is ſaid to anſwer on all lands, and to be capable of being managed by almoſt any ploughman. How far the expeditious way of preparing ground by this tool

* Experienced Farmer, vol. II.

may be effectual, muſt however be ſhewn by more general and extenſive trials than have probably yet been made with it.

The *Cultivator* is another tool calculated for the ſame purpoſes; the invention of Mr. Cook, to whoſe ingenuity the cultivators of land are greatly indebted. It conſiſts of a diagonal beam, in which are placed a number of narrow ſhares; and when employed in this way is in many places termed a tillage ſcarifier, but when uſed with broad triangular ſhares it has the title of ſcuffler. The whole, when complete, forms the cultivator.

All theſe kinds of implements may be conſidered as in ſome degree appendages to the drill, and may frequently be applied to the ſame wheels. In compariſon with the plough they ſeem, however, inſtruments of very limited uſe, yet in different inſtances they may be neceſſary and convenient in the management of arable land.

DRAGS.

These are tools of a ſomewhat ſimilar kind, and employed both for the purpoſes of clearing land and preparing it for putting in the ſeed. They are made with conſiderable difference in different parts of the kingdom. The common drag is moſt generally made uſe of, but the duck-footed one, with four rows of teeth, is preferable in many caſes, as it does its work more effectually. A late writer recommends an inſtrument of this kind, in which the teeth are fixed in by wedges inſtead of ſcrews, ſo that they can be put in and taken out readily, and be ſet to any depth, as a very uſeful tool *.

Implements of this ſort are commonly made of a triangular form, being about ſeven feet in width behind, and having thirteen or fourteen teeth in each of their ſides, ſet in ſuch directions as to croſs each other, being faſtened at top either by ſcrews or ſome other convenient means. Where ſuch implements are made uſe of occaſionally as ſcarifiers, the teeth ſhould be wedged in ſomewhat in the manner of coulters, and a proper ſet muſt be had for the purpoſe.

HARROWS.

Implements of this ſort are not only uſeful, but particularly neceſſary, in the practice of huſbandry, both for covering the ſeed and preparing the land for its

* Experienced Farmer.

kinds of land it muſt alſo be extremely liable to be prevented from working by the wheels being clogged and filled up. For putting graſs ſeeds into the ground, a ſmall light harrow, with ſhort teeth, is moſtly to be preferred.

A *Buſh-Harrow*, or that ſort of harrow which is formed by the interweaving of ſome ſort of buſh-wood into a kind of frame made for the purpoſe, and raiſed in the fore part by two ſmall wheels, may frequently be employed for the ſame uſe, as well as for harrowing in dung, or other earthy matters, into graſs lands.

Harrowing, in general, is by much the beſt performed by driving the horſe or horſes by whip reins of ſufficient length to permit the perſon employed to walk after the harrows. By this management he can clear the harrows as occaſion may require, and proceed in his buſineſs with greater diſpatch. It is now a pretty general obſervation among the intelligent cultivators of land, that the buſineſs of harrowing is more effectually and more advantageouſly performed by ſingle-horſe harrows, than by ſuch as require two horſes. In the attachment of theſe implements to the power which is to draw them, the common method is by a ſtrong ſort of ſtaple fixed to one of the corners of the harrow by a bolt; but a mode which appears more advantageous, is that of connecting the muzzle with a perpendicular pin at one corner of them *.

ROLLERS.

These are moſt commonly made of wood, caſt-iron, or ſtone, according as one or other ſort of material is moſt ready and eaſy to be obtained; and are of different ſizes and weights, in order to ſuit different purpoſes. In conſtructing heavy rollers, the workman ſhould be careful that they have not too great a diameter, whatever the material be of which they are formed, as the preſſure is diminiſhed where the implement is of very large ſize, by its reſting on too much ſurface at once, except an addition of weight in proportion be made. By having the roller made ſmall, when loaded to the ſame weight, a much greater effect will be produced, and a conſiderable ſaving of expence be made in the conſtruction of the implement. All the larger ſorts of rollers ſhould have double ſhafts, in order that they may be drawn by two horſes abreaſt; and ſuch as are employed for arable lands ſhould have a ſcraper attached to them. This addition ſaves much time, and prevents the driver the trouble of conſtantly ſcraping the machine, eſpecially in wet ſeaſons, and clayey tenacious lands. Strong frames are alſo neceſſary for rollers, ſo that proper weights may be put upon them; and open boxes or carts placed upon them may ſometimes be requiſite, in order to contain any additional weight that may be thought

* Agricultural Report of Perthſhire.

proper, as well as to receive ſtones or other matters that may be picked up from the ground. Pieces of wood or ſtone, as heavy as a man can lift, are the moſt ſuitable ſubſtances for loading theſe implements with, where they have not the advantage of boxes.

The *Common Rollers*, ſuch as are moſtly uſed for rolling wheat in the ſpring, and graſs ſeeds, are generally about five or ſix feet long, and from fifteen to thirty inches in diameter; but thoſe employed for flattening one-bout ridges, in order to prepare them for drilling turnips upon, are commonly ſhorter and of much leſs diameter.

Spike-Roller.—This kind of implement is formed pretty much in the ſame manner as the common roller, except in having the addition of a conſiderable number of ſpikes made to it. Theſe rollers are principally employed where the ſoil is ſtiff and cloddy, in order to reduce and break down the lumpineſs, and bring the land into a fine ſtate; and when well conſtructed are, in many caſes, good and effective tools for the purpoſe.

Drill-Roller.—The Norfolk farmers, we believe, have the merit of this invention. It is formed with rings of caſt-iron, round that part which conſtitutes the roller, at ſmall diſtances from each other; by which means drills are made in the land, and the intermediate parts riſing into ridges, the corn of courſe chiefly falls into them, being thereby better depoſited in the earth, and better covered than it would have been if ſown upon the furrows without them. The main object of this practice is the ſaving the expence of dibbling, though it is not by any means ſo good a practice. On light grounds, where preſſure is required, it may, however, be employed with great advantage. It may alſo be made uſe of in dry ſeaſons for reducing ſtiff clayey lands which are under fallow; for which purpoſe it is, perhaps, a more efficient implement than the ſpike-roller. Where this roller is made uſe of, the ſeed is ſown broad-caſt, and covered by means of a ſmall or buſh harrow. The wooden rollers which are frequently, and with great propriety, had recourſe to, for rendering graſs and paſture lands ſmooth and even, are in many places much too large to produce the powerful effect they are intended to have, without a proportionate increaſe of weight was added, for the reaſons which have been juſt given. They ſhould therefore be made leſs in ſize, and be loaded, in order to produce the great degree of preſſure which is wanted in theſe caſes.

As in turning at the ends of ridges or fields, rollers, from their not moving upon their axis, but being drawn along the ſurface of the ground, are liable to tear it up, and make deep holes and depreſſions before they come again into the direct line of draught, and are not brought round without great exertion in the team; it has been attempted, in order to obviate theſe inconveniences, to conſtruct rollers in two pieces, and by the diviſion in the middle to

enable the different parts to twiſt round on their proper axis, one forward and the other in a retrograde direction. When formed in this way, the cylinders are beſt when made of caſt-iron.

In the rolling of ground, eſpecially when ſuch rollers are employed as are compoſed of one piece only, it is by much the beſt method, where it can be accompliſhed, to go round the whole field in ſomewhat a ſpiral direction, and by that means keep continually proceeding without the neceſſity of making ſhort turns; and in rolling down graſs ſeeds with corn crops, this mode is in general to be preferred: but graſs lands may be rolled in any direction, though the mode of rolling ridges ſeparately is evidently more troubleſome than that of croſſing them.

THRASHING-MACHINES.

The thraſhing of corn, by means of machinery, has been long in uſe in the northern diſtricts of the kingdom, and mills of this ſort are now becoming general in moſt parts of the country; and upon arable farms of conſiderable extent they cannot but be highly advantageous, as they ſave much labour and expence. In the making of thoſe machines, attention ſhould always be had to the ſize of the farms, or rather the quantity of grain that may be grown on them, and the mill proportioned accordingly. They are moſtly conſtructed on the principles of the flax-mill, and are moved either by water or horſes, the firſt by far the beſt method where it can be had; the grain by theſe machines being, as it were, ſwingled out of the ears by means of beaters which are attached to a cylinder that moves with very great velocity. Since the introduction of theſe machines, many improvements have been made on them; a ſcreen has been added for the grain to paſs through into a winnowing-machine, and a circular rake to remove the ſtraw from it; as before this addition the ſtraw was forced out from the beater upon the upper barn floor, and required much time and labour in ſhaking and putting into order, which by this contrivance is ſaved. In working theſe mills, four perſons are commonly neceſſary; one takes the ſheaf from the ſtack, another places it ready for the third who is to feed the mill, and the fourth removes the ſtraw to prevent its collecting in too large a quantity. It has been objected to theſe machines, that they do not thraſh ſome ſorts of grain clean; this has been particularly the caſe with barley. It is, however, obſerved by an intelligent writer, that the circumſtance on which the good thraſhing of this kind of grain depends, is the iron covering under which the beating wheel, having ſix beaters, moves: in ſome machines this is fixed, while the beating wheel is capable of being raiſed or depreſſed at pleaſure; but a recent improvement is to render the

iron roof moveable, and the wheel fixed; and the iron is placed ſo near to the beaters that the grain is rubbed, as well as ſtricken out of the ear*. In ſome machines of this ſort, the beaters are a little rounded; but it is probably a better practice to have them of the common flat form.

In ſome large mills of this kind the rollers take in about three hundred inches of grain in a minute. The medium length of the ſtraw being eſtimated at about thirty inches, and ſuppoſing half a ſheaf to be introduced into the machine at a time, the whole ſheaf will be equal to ſixty inches, and the machine when ſupplied with a middling quantity of water will thraſh five ſheaves in a minute. But in reſpect to the performance of theſe mills much muſt depend on the attention with which they are fed, as a ſmall neglect in this point will make a very conſiderable difference in the quantity of work done.

An excellent deſcription of a mill of this nature is given in a late publication, in which it is remarked, that in ſuch mills five people are commonly neceſſary to keep the work going on without embarraſſment; but that this depends greatly on the conſtruction of the machine, ſome of them being ſo contrived, that the work can be performed with much fewer hands. The manner in which theſe people are employed is this: One finds conſtant work in carrying the ſheaves to the man who feeds or puts the unthraſhed corn into the machine, and in looſing the bands; another is required to feed the machine; a third to carry off the ſtraw; the fourth to attend the fanners, and lay aſide the cleaned grain; and a fifth, where horſes are made uſe of, to take care that they go regularly; and that by means of five men and four horſes they will thraſh at the rate of five quarters in the hour on a medium, and when the crop is rich, and eaſily thraſhed, conſiderably more: conſequently if a thraſhing-mill was to be employed for a whole day, or nine hours, it would thraſh forty-five quarters; but in that caſe it would be neceſſary to employ two ſets of horſes. The expence is calculated in this manner:

	£.	s.	d.
Hire of eight horſes, at 2*s.* 6*d.* each per day, . . .	1	0	0
Five men's wages, at 1*s.* 6*d.* each, ...	0	7	6
	£.1	7	6

In this account the hire of the men and horſes are, it is conceived, charged at the higheſt rate, and that the expence of thraſhing forty-five quarters of grain would coſt 1l. 7s. 6d. or about 7d. each quarter. But that taking the average expence of

* Young's View of the Agriculture of the County of Lincoln.

thrashing forty-five quarters of grain with the flail, throughout the whole kingdom, including an equal proportion of all kinds, cannot be, it is supposed, estimated at less than 3l. 7s. 6d. or 1s. 6d. each quarter, which makes a difference of about 11d. each quarter. It is also farther observed, that since the introduction of these mills, the grain is thrashed by the ordinary servants on the farm, and without in any material degree obstructing the operations in the field; farmers in general employing their men and horses in this business in bad weather, when other operations cannot be carried on.

The whole expence of constructing a thrashing-mill, including the building of the shed for covering the great wheel, does not, in almost any case, exceed 100l. The ordinary annual repairs may, one year with another, amount to 5l., which added to the interest of the prime cost, makes the yearly expence 10l.; a sum for which any quantity of grain, however great, that may be supposed to grow on one farm, can be thrashed, and that too in a manner much superior to what can be done by manual labour. The expence either of erecting these machines, or of keeping them afterwards in repair, must be considered by every intelligent occupier of a corn-farm as a secondary object, when compared with the advantages that are derived from them; such as the performing of the operation at less than half the ordinary price, and affording the farmer the means of securing his grain from being embezzled: besides, the saving, in regard to superior clean thrashing, as has been now well ascertained, is not only more than the annual expence of repairs, but so great as, on a farm of considerable extent, to reimburse the farmer for the whole of his expenditure in the course of a few years. Therefore, considering the increasing scarcity of labourers, and the recent great advance in the rate of labour in all the better cultivated parts of the kingdom, the introduction of thrashing-mills into common use cannot but be highly beneficial.

There is, however, one difficulty in the introduction of thrashing-mills into the southern parts of the kingdom, which arises from the manner of harvesting all kinds of grain, except wheat, which cannot probably be easily removed; as the corn, in order to be clean thrashed, should be put into the machine as straight and regular as possible. For while the sheaves, after being loosened and spread on the board, so as to be easily taken in by the feeding rollers, are passing between them, they keep the straw steady, by which means the strokes of the beaters or scutchers operate with more force and effect in separating the grain from the ears; whereas, if the unthrashed corn goes in sideways or irregularly, the thrashers can have but little power upon it. This would no doubt frequently happen in thrashing corn which has been mowed with the scythe, and which is harvested in every respect like hay, so that unless the

unthraſhed grain be put into the mill in ſmall quantities, it is almoſt impoſſible that it can be completely ſeparated from the ſtraw*.

But though, when the ſize of the machine is conſiderable, the expence of erecting it may be from eighty to one hundred pounds, according to ſituation and materials, ſmaller ones may be erected at much leſs, as from thirty to fifty pounds.

Some of theſe kind of mills have rollers or ſmall mill-ſtones added to them, for the purpoſe of cruſhing and grinding grain for horſes, ſwine, and other animals; and alſo inſtruments for cutting ſtraw into chaff.

On the neceſſity of employing machines of this kind, it is remarked by an able writer, that it is the only method left for having the corn cleanly and properly thraſhed. They are ſo quick in the work, that the whole may be done under the eye of the maſter, and the corn ſecured in the granary without the leaſt pilfering. The ſaving, by this means of thraſhing, in the extra quantity of corn procured, and the ſecurity againſt having the corn ſtolen in the chaff, it is aſſerted, amounts to an advantage in favour of the mills of about ten per cent on the corn crops; in ſome caſes, to one ſhilling a buſhel on wheat, and very generally to twenty ſhillings an acre on the wheat crops†.

This machine has undoubtedly many advantages over the flail, as well as thoſe of ſaving time and hands; as in thraſhing damp corn, not capable of being fully accompliſhed in any other way, eſpecially in wet ſeaſons; and with ſmutty wheat, which is thraſhed by it without any miſchief being done to the ſound grain, the ſmut not being cruſhed comes out whole, and is blown away with the chaff.

The principal objections that have been made to theſe machines, are the great expence of erecting and uſing them, their tendency to diminiſh the labour of the poor, and their affording too great a ſupply of ſtraw at a time. Theſe objections are, however, of little conſequence, when the general utility and advantages of ſuch machines are conſidered; beſides the latter are either ſuch as have nothing to be apprehended from them, or as may be readily obviated. The difficulty in regard to the ſtraw may be eaſily removed, by having it properly ſtacked up or cut into chaff.

WINNOWING-MACHINES.

Machines of this ſort are in pretty general uſe, where thraſhing mills, to which they may be attached, are not erected: they are made on different principles accord-

* Donaldſon's Modern Agriculture.

† Middleton's Report of the Agriculture of Middleſex.

ing to particular circumstances. Those contrived by Mr. Cor, of Leicester, on Mr. Winlow's plan, are good implements, and will dress grain with much dispatch. And there are others which are employed in the northern districts, which are made by Rodgers, that are also upon good and convenient principles: as well as many more in different places which have great merit in their construction, and do their work well and expeditiously. They are made of different prices, from three to five or six pounds, and will last many years when the materials of which they are formed are of a proper kind.

CHAFF-CUTTERS.

Of these useful implements there are a great variety formed on very different principles. There seems, however, in general, to have been too little attention paid to their construction, as there is scarcely one so cheap as to be suited for general use. Those made on Mr. Cook's and Mr. Nailor's plans are in much esteem in many places; but one lately constructed by the successors of Mr. Winlow and other manufacturers, in which the straw is regularly brought forward by an iron cylinder contrived for the purpose, as the implement is turned round, and cut by means of three knives fixed on the wheel, would seem to be more convenient. Straw may, however, be well and expeditiously cut by almost any of these implements; but in many districts, from their great expence, the common cutting-box is still in use.

As the principal objects aimed at in this sort of machine are those of expedition, and the lessening of labour, it is obvious that many of the improved instruments of this kind must answer these purposes much more effectually than those that were formerly in use, especially where they are attached to any great power, such as that of horses or water, as in the case of thrashing-machines, or other mills, for which they are in common adapted.

RAKES.

Implements of this kind are employed for different purposes in practical husbandry.

The common *Hay-Rake* is too well known to require any description; but a late improvement upon it seems to deserve notice. This is the making of the teeth to screw into the heads, and fasten with screw nuts, by which the danger and inconvenience of their dropping out is prevented.

With these *Spring-teeth-Rakes* one person is said to do considerably more work than with the common wood rakes; and they are made use of both for hay and

corn with great eaſe and convenience. Rakes are conſtructed in this way, and ſold by Mr. Cort of Leiceſter.

The *Corn-Rake* is a large rake made uſe of in many diſtricts for raking together the grain after it has been mown. It is ſometimes made with wooden teeth, ſeven or eight inches in length; but as theſe are very apt to break, it is a much better method to have them of iron, in which caſe they ſhould be a little bent forward. As it requires great exertion in uſing theſe rakes, they ſhould be conſtructed in as light a manner as is conſiſtent with the work they have to perform.

The *Twitch-Rake* is a ſort of rake which is frequently neceſſary for the clearing of certain deſcriptions of land from theſe, as well as other kinds of weeds. The beſt way of making it is probably with a double row of teeth, thoſe of one row being placed oppoſite the intervals of thoſe of the other. By this means it is rendered a more convenient and effectual implement.

The *Horſe Stubble-Rake* is a large heavy kind of rake, with ſtrong iron teeth, fourteen or fifteen inches in length, placed at five or ſix inches diſtance from each other, having a beam about four inches ſquare, and eight or ten feet in length. It is commonly drawn by two horſes, and is very effective in clearing ſtubbles.

Wheel Carriages for Huſbandry.

The *Waggons* which are employed in huſbandry are conſtructed in different forms, and of various dimenſions, in different diſtricts; and, in general, without ſufficient attention to the nature of the roads, or the materials that are to be carried. They are indeed commonly much too heavy and clumſy to be convenient. The Berkſhire waggon would ſeem, however, to be conſtructed on a more neat and convenient principle than thoſe which are made uſe of in moſt of the more ſouthern counties: it is neither ſo heavy nor ſo high, while it poſſeſſes ſufficient ſtrength, and is eaſy in the draught.

A very uſeful improvement in this carriage has been ſuggeſted in a late publication, which is that of leaving the ſpace ſufficiently deep in the bed of the waggon for the fore wheels to lock round in the ſhorteſt curve, as by the preſent mode of conſtruction much time is loſt in turning at the ends of ſwaths in carrying hay, and on many other occaſions. In this way the inconvenience may be removed without doing the ſmalleſt injury to the ſymmetry or ſtrength of the carriage *. But thoſe employed in Glouceſterſhire are preferred to any others in the kingdom, by an

* Agricultural Survey of Perkſhire.

intelligent writer, who has attended much to the ſubject; as by means of a crooked ſide-rail, bending archwiſe over the hind wheel, the bodies or frames of them are kept low, without the diameter of the wheels being much leſſened. The bodies are likewiſe made wide in proportion to their ſhallowneſs, and the wheels run ſix inches wider than thoſe of moſt other waggons, whereby advantages in carrying top-loads are evidently obtained *.

In many diſtricts, waggons are the principal carriages employed in getting in the hay and corn, and carrying them to the market, and likewiſe in bringing manure, coals, and various other materials. In ſuch caſes they are generally drawn by the whole team on the farm, and two men, or a man and a boy, are neceſſary to attend them in performing the buſineſs.

But this ſort of conveyance, however well conſtructed, from its great weight and unwieldineſs, as well as its expence, ſeems far from being advantageous to the intereſts of the farmer; as while it is highly deſtructive of the roads, it requires great power in the draught, which muſt be procured at much expence, without affording an adequate compenſation in the quantity of materials which it conveys. It is however ſuppoſed by a later author, that in performing diſtant carriages, where the roads are level and ſubſtantially made, and the waggons at all times *fully loaded*, one of them may probably be as advantageouſly uſed as two or more carts of leſs dimenſions; but that where labour is required to be performed with expedition, as in the harveſting of hay and corn, ſuch unwieldy machines are ill calculated for the purpoſe; and that on every occaſion, where they return only half or a third part loaded, the farmer muſt obviouſly ſuſtain a conſiderable loſs †.

The uſe of heavy carriages being found inconvenient in performing ſome ſorts of buſineſs, farmers, in particular inſtances, have had recourſe to a lighter ſort of vehicle for conveying manures, and other materials of the ſame kind, upon land, while large waggons are employed for other purpoſes. In this way the improved *Iriſh car* has been made uſe of, and found well adapted to the conveyance of ſuch ſubſtances, a good horſe being capable of drawing with eaſe and expedition more than a ton weight.

In its conſtruction it approaches much to the ſquare form, being only a few inches longer in the bed than it is broad; the wheels are made low and broad, with a flat bearing, and placed under the body of the machine. From theſe different circumſtances it poſſeſſes many advantages; it can be readily filled, paſs confined gateways with facility, and be drawn upon ſoft meadow or ploughed grounds with much leſs injury and inconvenience. From the cylindrical form of the rims of

* Marſhall's Rural Economy of Glouceſterſhire.

† Donaldſon's Modern Agriculture.

the wheels much less resistance is said to be given in the draught *; consequently heavier weights can be drawn. The business of husbandry in Ireland is chiefly performed by this sort of small carts where hay or corn in the straw is to be carried, ladders being added. They are, however, thought inferior to the single-horse cart by some persons who have closely attended to them †.

CARTS.

The *Carts* used in agriculture are made with much variety in different districts, but, like waggons, are probably, in general, too heavy in their construction to be employed with the greatest advantage. In some places they are so formed as to be, when empty, full as heavy as one horse can draw, especially where the wheels are broad, and of course much resistance occasioned by the increased friction. Nothing can, indeed, be more injudicious than the enormous bulk and clumsiness of the farm carts commonly employed in some districts; and the inconvenience and loss that result from the use of such clumsy carriages are greater than can be easily imagined. Besides, in consequence of the great height of the wheels, the nave, spokes, and fellies, must all be made of such weighty materials, in order to render them *moderately* strong and firm, as not only to add a prodigious unnecessary load to the horses, but greatly to enhance the expence of such vehicles. The difficulty of loading the cart, too, is so much increased from the same cause, as at least to double the expence that it might be performed at. And, on account of the number of horses that are required to draw them, and the time lost by the men in filling them, as well as the damage done upon retentive subsoils by their being torn into deep ruts, they are clearly shewn to be less advantageous than those of the smaller kind. Lightness in a carriage that is to go upon land, is a quality of the first importance in the business of a farm; this is particularly evident when it is considered that by such means, with the same strength of draught, more than four times the quantity of work can be done in the same length of time. Low wheels in vehicles of this sort also enable a much heavier load to be drawn; and of course render small carts preferable on that ground as well as those that have been stated. Carts, if properly constructed, for many kinds of weighty goods need not, independent of wheels and axle-tree, weigh more than one hundred weight, and for most purposes they need not exceed two hundred weight. Large waggons, as well as heavy-constructed carts, should, therefore, except in particular situations, be exchanged for those

* Cummings's Paper in Communications to the Board of Agriculture, vol. *II.*

† Annals of Agriculture, vol. XVIII.

of the lighter kinds, by which more work may be performed in an equal length of time, and with much greater eaſe and convenience.

Single-Horſe Carts.—The large wains, or heavy four-horſe waggons, which are common in many of the ſouthern counties, are not only reprobated, but in a great meaſure exploded in thoſe of the north, where one and two horſe carts, with ſome variety of conſtruction, are moſtly made uſe of. One horſe with theſe carts draws from twelve to twenty-four hundred weight, and on good road ſometimes thirty, with great facility. In the moſt improved cart of this ſort, the bottom, when placed on the axle, projects, on each ſide, over the inner heads of the naves, ſo as nearly to touch the ſpokes of the wheels; from which acquiſition of breadth the capacity of the cart is much increaſed, while the ſide ſtandards, by being brought nearer to the perpendicular ſituation, are enabled to ſuſtain conſiderably more weight. This is termed the *Cloſe* or *Coup Cart*, and is about five feet three inches in length, four feet in breadth below, and four feet three inches above, having a depth of one foot three inches, and containing about a cubic yard. The wheels are commonly about fifty inches in height, and the axle-tree moſtly formed of iron, though wood will anſwer the purpoſe tolerably well.

A very intelligent agriculturiſt, who has paid much attention to the importance of carts in huſbandry, found in conſtructing ſingle-horſe ones that the capacity of waggons was by no means a juſt rule for them. From thoſe with which he was acquainted, containing in the bed, or *buck*, ninety-ſix cubical feet, being twelve feet long, four feet wide, and two feet in depth; it was ſuppoſed that to give one horſe the fourth of the load of four, it would only be neceſſary to give them a ſpace of twenty-four cubical feet, or to make them four feet by three, with a depth of two feet; but it was ſoon obſerved that the power of a horſe was ſo much greater in working ſingly than in a team, that they might be enlarged ſo as to have the dimenſions of five feet one inch in length of *buck*, three feet ſeven inches in breadth, two feet in depth, and to contain thirty-five cubical feet and a fraction. This places in a ſtriking point of view the advantage ſuch ſmall carts have over large ones in the quantity of work performed *.

On the ſubject of ſingle-horſe carts it is alſo obſerved by another practical writer, "that thoſe which are in uſe in various parts of England appear to be the beſt calculated for the purpoſe of carrying all kinds of goods, except ſingle trees, blocks of ſtone, or any other article whoſe weight may be too much for the ſtrength of ſuch carts, and which cannot eaſily and without loſs be divided into ſeparate loads; in all or moſt places where the roads are particularly bad, either ariſing from ſoft

* Annals of Agriculture, vol. XVIII.

mud and clay, or large stones, and where there are deep ruts, especially in hilly countries, and where the people are poor, and consequently particularly studious to keep their expences under as much as possible.—These are the places * and the people with whom single-horse carts are in common use; and is a strong proof of the economy of the plan." "It is equally certain," he observes, "that where the country is level, the roads free from ruts, and the people rich, they indulge in expensive horses, and in teams of parade and show. Such, for instance, as those used by the brewers and distillers of Middlesex and Surrey." It is also farther stated, that he has four of these one-horse carts in use himself; and that in loading the gravel of flints they are always filled to carry twenty-five cubical feet, and for manure from thirty to forty †. The great superiority of these carts is rendered still more obvious and striking by the observations that "two horses, yoked in single-horse carts, will draw as much as three horses yoked in one cart; that a common carrier at Carlisle who many years employed a waggon, has laid it aside, and now uses single-horse carts only; as he finds he can, by that means, carry much greater weights ‡."

It is likewise supposed in the same work, that the superior goodness of the roads in Cumberland may be ascribed to the general use of single-horse carts; and that wherever waggons are employed they are the destruction of roads, especially where the country is hilly, and where they are under the necessity of having the wheels locked, as in such cases the banks are in a manner ploughed up by them. The same objections are equally strong against large and heavy carts, as they produce the same bad effects only in a somewhat less degree.

It is, in short, strongly contended that waggons cannot be advantageous to the farmer, since the same number of horses yoked in single-horse carts will draw considerably more than when yoked six or eight together. Besides, it is conceived that single-horse carts are superior on other grounds; they are loaded and unloaded with greater ease and convenience, and are more handy for almost every purpose, and six or eight of them may be managed by a man and a boy at very little expence.

In these carts too, the size of the wheels can be adapted with the greatest exactness to the height of the horses, and be placed with more convenience in regard to the centre of gravity of the load, by which the draught is considerably lessened.

* The mountainous districts of Derbyshire, Wales, Cumberland, Dumfries, Dumbarton, &c. &c.

† Agricultural Report of Middlesex.

‡ Agricultural Survey of the County of Cumberland.

In fact the Cumberland farmers, and thoſe of ſome other counties, are fully convinced that very great advantages are derived from uſing carts of the ſingle-horſe kind. This ſort of cart has likewiſe been compared in many different points of view by an accurate obſerver, and found in almoſt every inſtance to be greatly ſuperior to waggons, or tumbrils, for almoſt all the various purpoſes of the farm *.

Where ſmall carts are employed, it is frequently the cuſtom to have different ſorts for different purpoſes; thoſe of the cloſe kind being principally employed in carrying out dung, compoſt, and ſuch-like compact heavy materials; while others made of a kind of frame-work are occaſionally placed on the ſame wheels, and uſed for conveying bulky loads, ſuch as corn in the ſtraw, hay, and other ſimilar ſubſtances, and which are in conſequence denominated *corn* and *hay* carts. But the ſmall cart, which is termed *farmer's-cart*, as well as moſt of the ſmall-ſized carts, and all thoſe of the larger kinds, by having ladders attached to them at the ends and ſides, may be conveniently employed for all the purpoſes of the farmer, without the trouble, inconvenience, and expence, of ſuch a number of different ſorts of carts.

A very convenient and uſeful form of cart for almoſt all farming purpoſes, eſpecially in hilly diſtricts, is in uſe in ſome parts of Wales, as about Llandillo; it is commonly drawn by three horſes, one in the ſhafts, and two abreaſt before. The wheels are ſo made and placed, that the weight principally lies on the perpendicular ſpoke; the body of the carriage is ſhort and rather broad, but made with ſuch a curve as to give the load an inclination towards the axle-tree. This cart ſerves different uſes; the body conveying dung, coals, &c. while by the addition of ſhelvings in the way juſt noticed the different crops can be carried with great facility.

When carts are intended for the quarry, and conſequently carrying very heavy weights of ſolid materials, ſuch as broad flat ſtones, ſlates, &c. they ſhould be made low and without ledges, in order that they may be loaded and unloaded with care and convenience, and be ſufficiently ſtrong to prevent their giving way under the preſſure of ſuch loads.

Some ingenious improvements have lately been made in carts, in order to prevent the too great rapidity of their motion in going down ſteep hills, and for adjuſting the poſitions of the centre of gravity of the load, ſo as to have a ſuitable bearing on the horſe, or other animal, which draws them in ſuch caſes. The firſt has been effected by means of friction on the ſides of the wheel, by the application of what is termed a friction-drag, inſtead of the uſual inconvenient and dangerous method of locking the wheels: and the latter by a kind of toothed rack faſtened to

* Young's Annals of Agriculture, vol. XVIII.

the front of the cart by a ſcrew, and worked by a pinion and handle fixed to the pole, where the cart is made to be drawn in that way; and ſo contrived as to admit of the fore part of the cart being elevated in proportion to the ſteepneſs of the declivity, by which means the weight of the load is thrown more upon the axis, and conſequently relieves the necks of the cattle which are employed in the draught. Another more ſimple method of accompliſhing this point is by a ſtrong piece of iron, which is bent ſo as to form part of the arch of a circle, the radius of which is nearly equal to its diſtance from the axis of the cart, and which is perforated with holes, for the admiſſion of a ſtrong iron-pin, by which the body of the cart is kept at any deſired inclination with the pole.

The friction-bar, or drag, by being connected with the tail of the cart by a ſmall chain, and to the front by a cloſely notched or toothed rack that catches on a ſtrong ſtaple, can be made to afford different degrees of preſſure on the ſides of the wheel, according to the nature of the hill, or the inclination of the driver *. From the circumſtance of this application of the drag, it has been termed a *drag-cart*.

By theſe ingenious and ſimple contrivances many advantages are produced, the danger to which horſes and drivers are frequently expoſed is obviated, much time ſaved, and the deſtruction of the roads conſiderably leſſened.

As it has been ſhewn that thoſe parts of the neck and ſhoulder-blades on which the collars reſt in draught-horſes have that degree of ſlope, or inclination, which forms an angle with the horizon of about fourteen or fifteen degrees, it is plain that the line in which they draw ſhould form the ſame angle; as in that caſe they will pull in that line of direction which coincides the moſt with the ſhape of their ſhoulders, and, of courſe, all the different parts of their ſhoulders will be equally preſſed or acted upon by the collars. Hence horſes draw more in conformity to their mechaniſm in a ſloping, than an horizontal line of direction; and the power or advantage which they have in overcoming the reſiſtance of obſtacles in this direction is likewiſe *mechanically* great, as may be eaſily demonſtrated. On theſe principles, therefore, ſingle-horſe carts muſt be more advantageous than teams, as in the latter caſes many of the horſes muſt draw in a horizontal direction, conſequently in a way that is inconſiſtent with their mechaniſm, and the eſtabliſhed principles of mechanical ſcience †. This likewiſe places in the moſt clear and ſatisfactory point of view, the neceſſity of having the wheels in all ſorts of carts properly adapted to the ſize of the horſes or other animals employed in them.

* Lord Somerville's Paper in Communications to the Board of Agriculture, vol. II.

† Walker's Syſtem of Familiar Philoſophy, p. 167.

But notwithstanding the evident advantage of employing single-horse carts in many districts in preference to waggons and heavy carts, it is obvious, from the nature of the roads and grounds, as well as many other circumstances in other places, that they cannot be generally had recourse to; but that in respect to the construction of them, as well as to most other implements made use of by the husbandman, there must be a difference according to the nature of the situation and the lands and roads on which they are to be employed. It must, however, be admitted, that in most of those districts in which a number of horses are put into one cart, considerable advantages may be derived from a reduction in their weight, and from their being made in a less clumsy manner, as well as from the rims of the wheels being made cylindrical instead of the usual conical form.

† Cummings's Paper in Communications to the Board of Agriculture, vol. II.

SWING PLOUGHS.

Fig. 1.

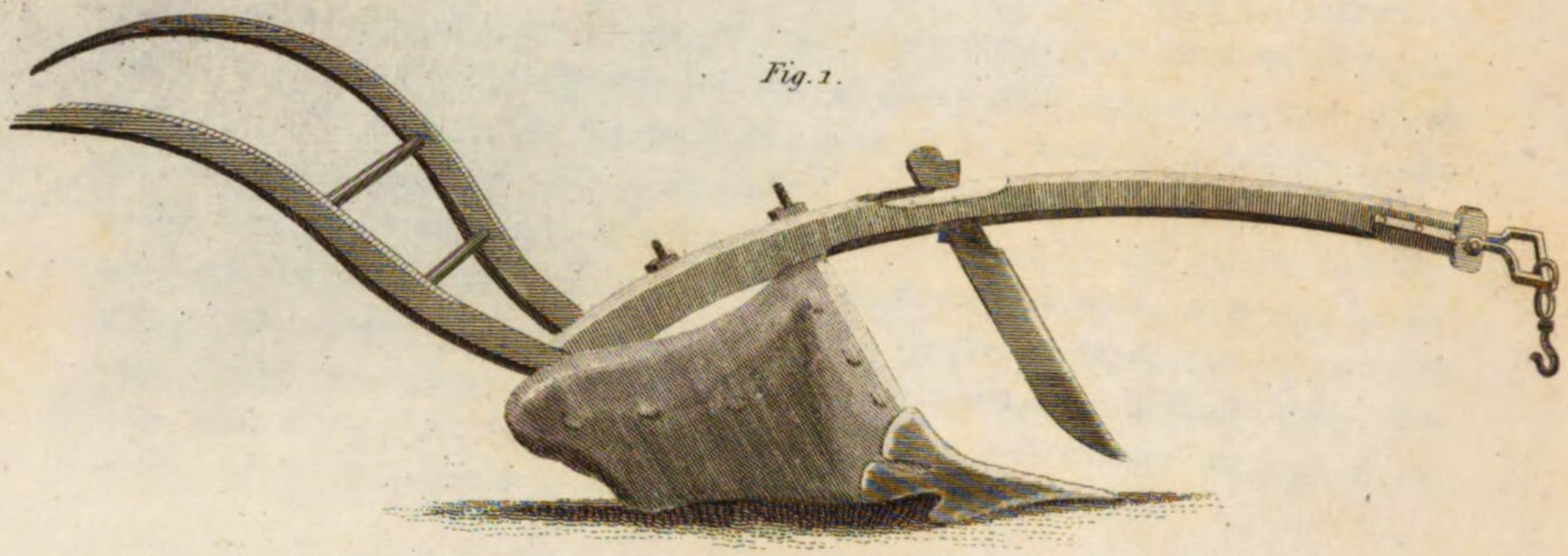


Fig. 2.

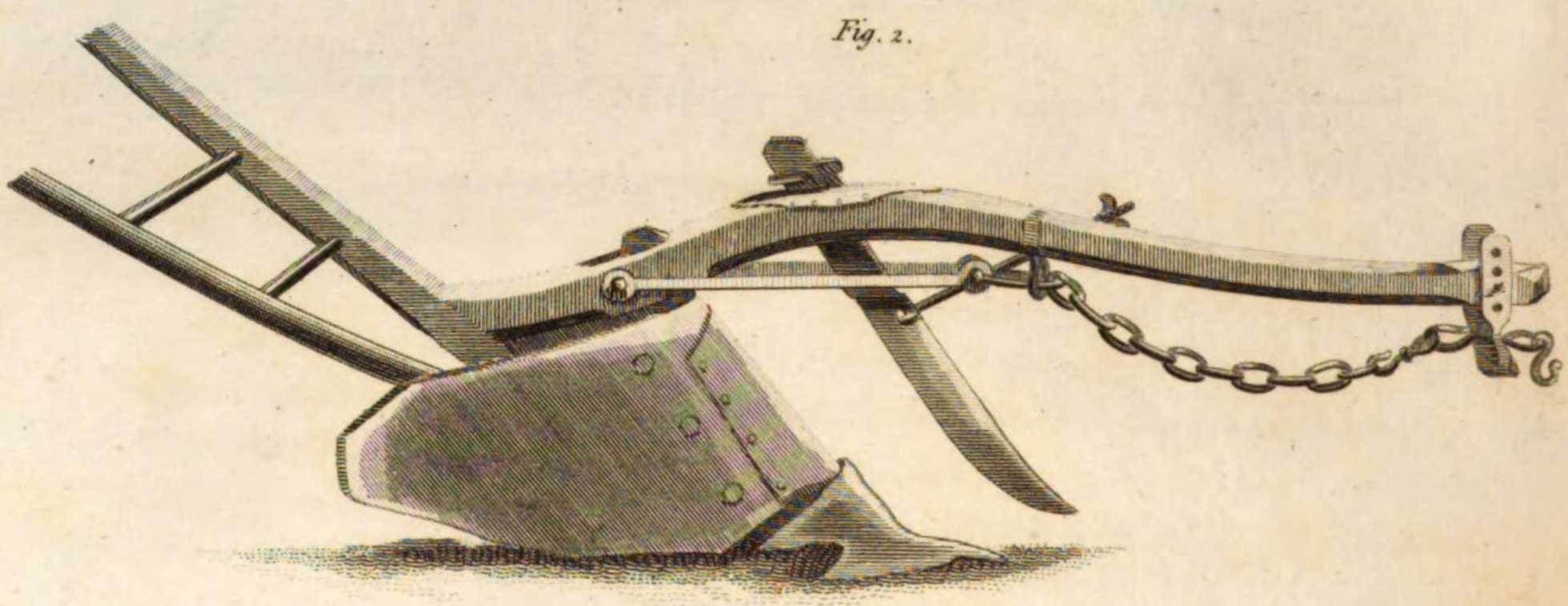


Fig. 3.

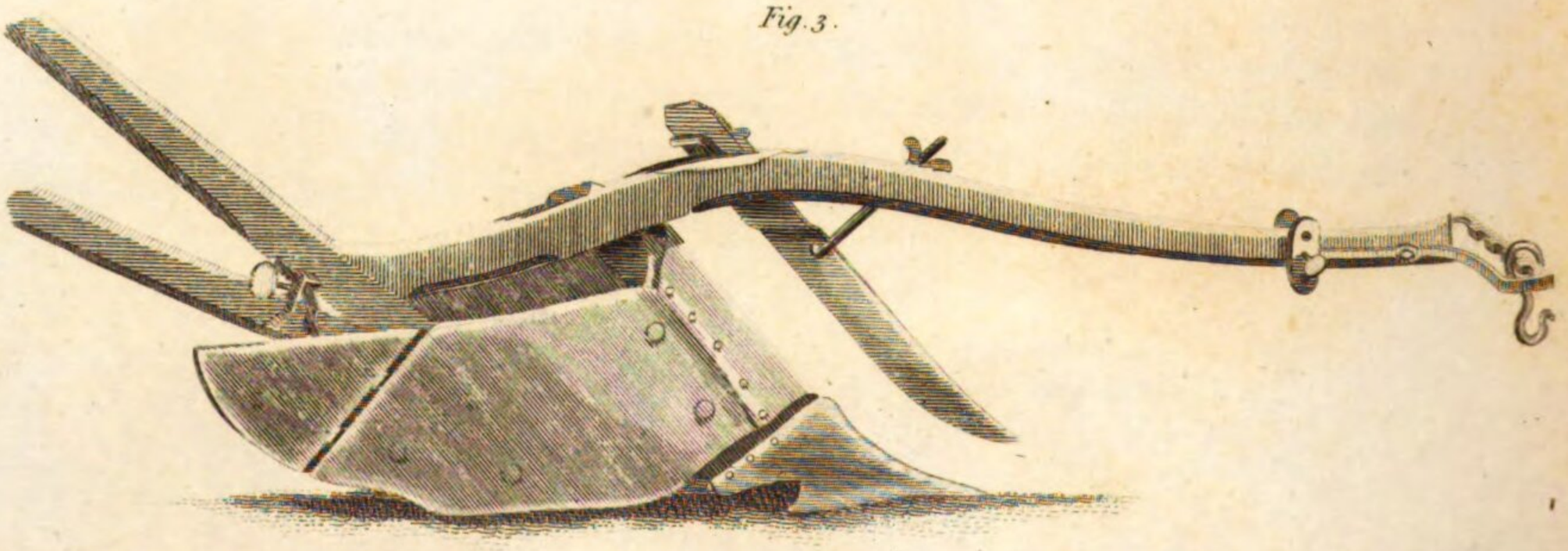


PLATE II.

Swing-Ploughs.

[*To face Page* 40.]

Fig. 1. Is a repreſentation of the Rotheram or patent plough. As this ſort of plough is not incumbered with wheels, it muſt be the moſt free from friction, and the reſiſtance which neceſſarily proceeds from that cauſe; conſequently, may in general be ſaid to be the lighteſt of draught.

Fig. 2. Repreſents Small's chain-plough, which will be found highly uſeful in cultivating ſtrong lands and rough grounds; for, ſhould the ſhare, or coulter, ſuddenly meet with any obſtruction, the ſtrain would be immediately thrown upon the chain, inſtead of the beam.

Fig. 3. Is a ſwing-plough, with Lord Somerville's improved mould-board.

From the clean ſharpened conſtruction of the breaſt and throat of this plough, deep ſtiff land may be broken up with great ſucceſs; and as the extremity of the mould-board is moveable, the furrows may be laid more or leſs flat, according to the circumſtances of the caſe.

[To face Page 40.]

KENTISH AND NORFOLK PLOUGHS.

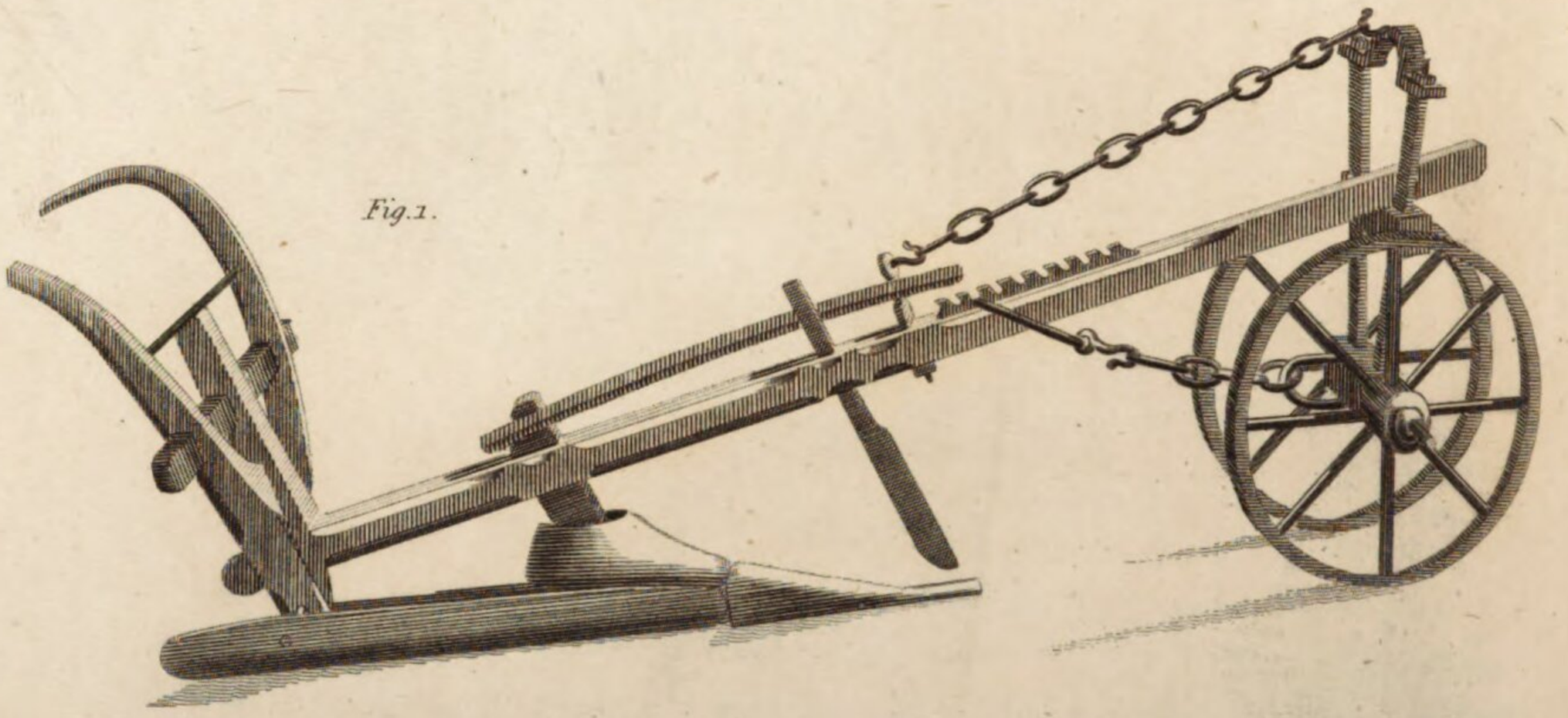


Fig. 1.

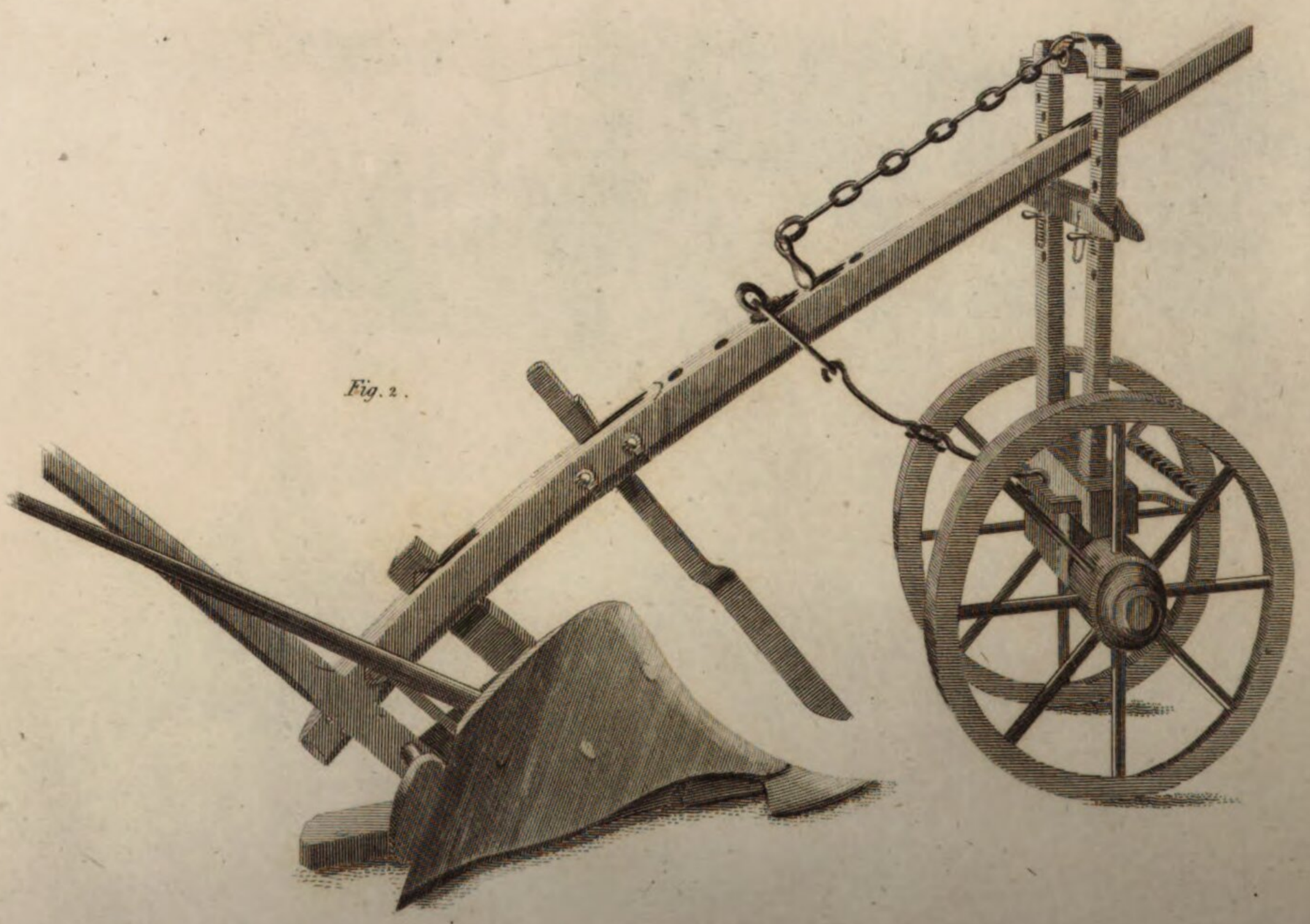


Fig. 2.

PLATE III.

Kentiſh and Norfolk Ploughs.

[*To face Page* 40.]

A repreſentation of the *Norfolk Plough* is given at *fig.* 1. The head and beam are ſhort, but carriage part or wheels ſtand high; by which means the fore end of the beam is much raiſed, and the horſes are more conveniently driven. It is uſually drawn by two horſes abreaſt, the ploughman guiding them by reins. It is an uſeful plough in ſuch light ſoils as it is generally employed upon.

At *Fig.* 2. is ſeen the *Turn-wreſt or Kentiſh Plough*, a powerful implement in ſtiff ſtrong ſoils, but very heavy. It is uſed in Kent with four horſes abreaſt, and anſwers well among flints or rocks, and in dry ſoils, from its going deep and laying the furrow ſlice quite flat, without any opening in the ſeam. It coſts, complete, 5*l.* 5*s.*

Mr. Boys deſcribes it as conſiſting "of a beam of oak ten feet long, five inches deep, and four broad; behind which is a foot, five inches by three and a half, and three feet and a half long, on the top of which the handles are placed; the foot is tenoned to the end of the beam, and mortiſed at the bottom to the end of the chep. Through the beam, at two feet five inches diſtance from the foot, is a ſheath of oak ſeven inches wide and one and a half thick, which is mortiſed into the chep in an oblique direction, ſo that the point of the ſhare is twenty-two inches diſtant from the beam. The chep to which the ſhare is fixed is five feet long, four inches wide, and five inches deep. The ſhare is of hammered iron, weighs about thirty-two pounds, is twenty inches long, and from four inches and a half to ſeven inches wide at the point.

"The upper end of the beam reſts on a carriage with two wheels, three feet two inches high. On the axle-tree is a gallows, on which is a ſliding bolſter, to let up and down. Through the centre of the axle is a claſp-iron, to which is fixed a ſtrong chain called a tow, that comes over the beam, ſo fixed, as by means of notches (or a pin called a check) to let the whole plough out a greater length from the axle, thereby letting it down to a greater depth."

COMMON WHEEL PLOUGHS.

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 5.

PLATE IV.

Common Wheel-Ploughs.

[*To face Page* 40.]

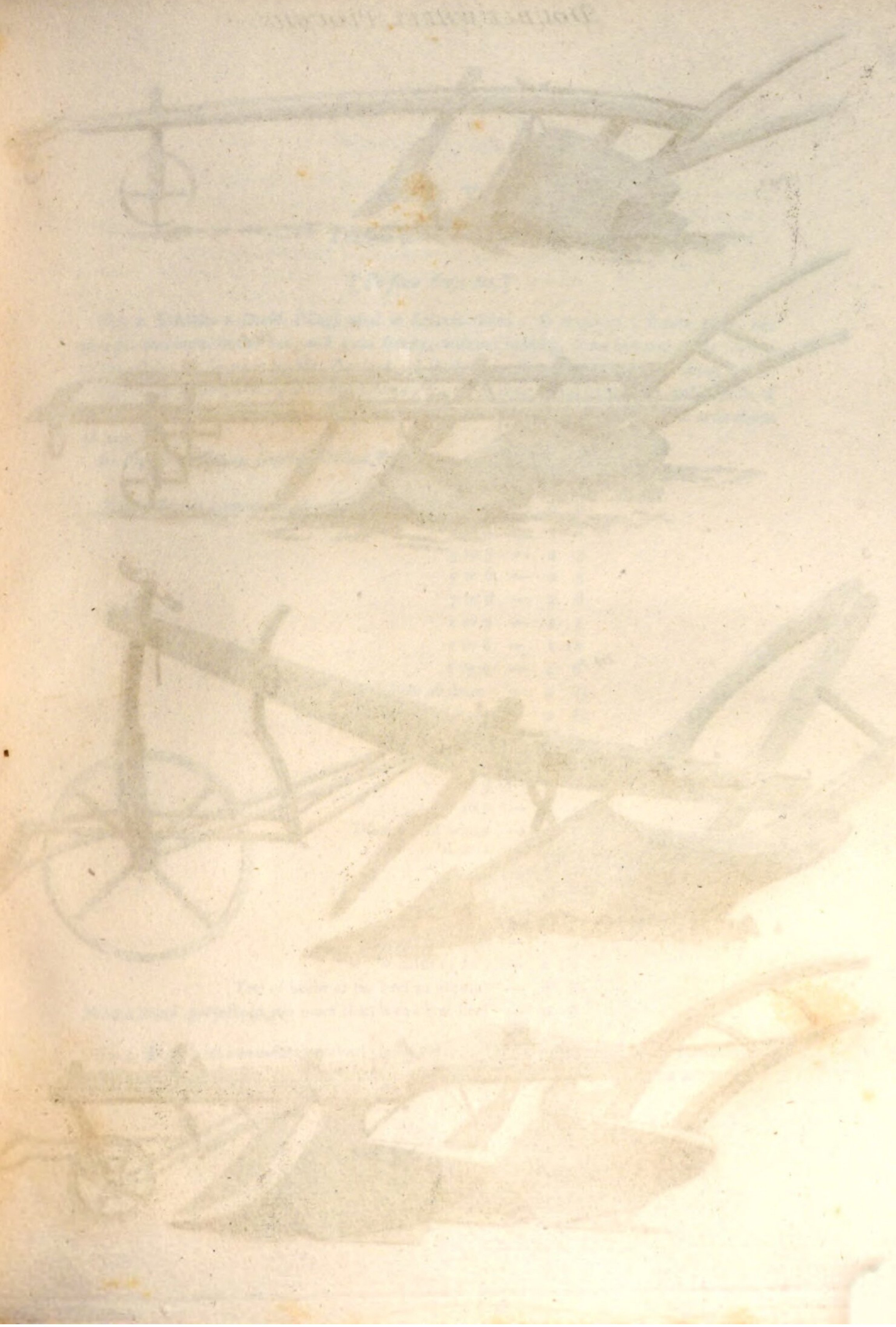
Fig. 1. Is the repreſentation of a wheel-plough of the Rotheram kind.

Fig. 2. A common wheel-plough uſed in many diſtricts.

Fig. 3. Is a double mould-boarded wheel-plough, employed for the purpoſe of earthing up crops ſown or ſet in rows at great diſtances.

Fig. 4. Is a ſort of fen plough which has been found uſeful in Lincolnſhire. It has a cutting wheel as ſeen at *a*.

Fig. 5. Is a marking plough, ſometimes uſed for regulating the drills, where that ſort of huſbandry is to be employed; but more particularly uſeful for marking out ridges.



DOUBLE WHEEL PLOUGHS.

Fig. 1.

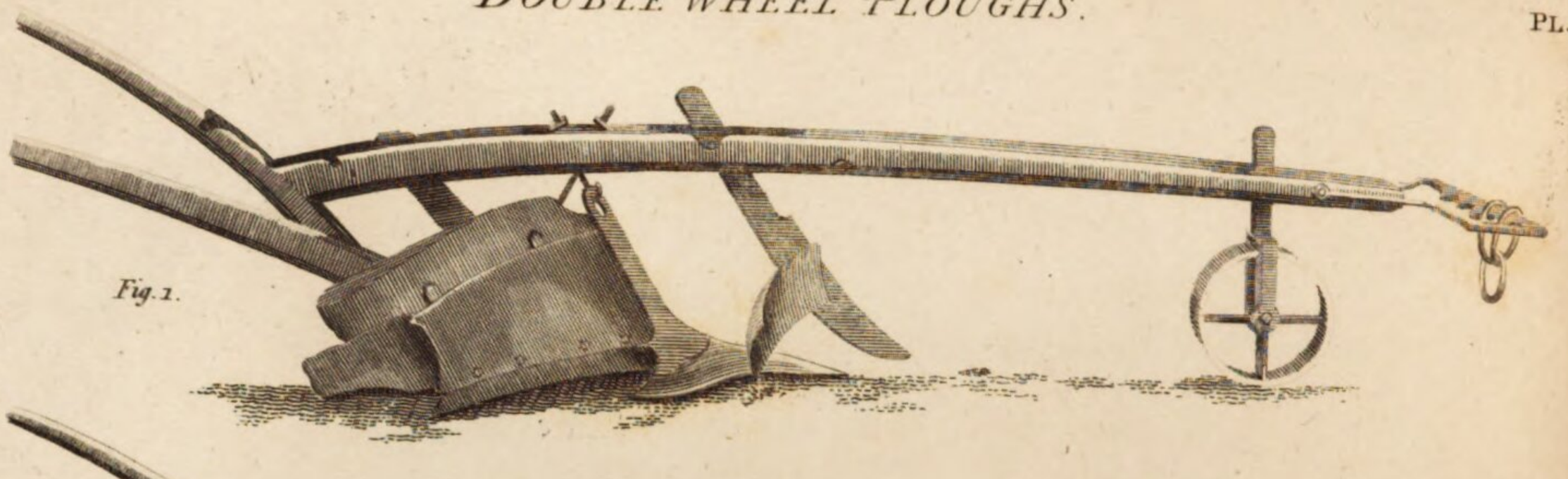
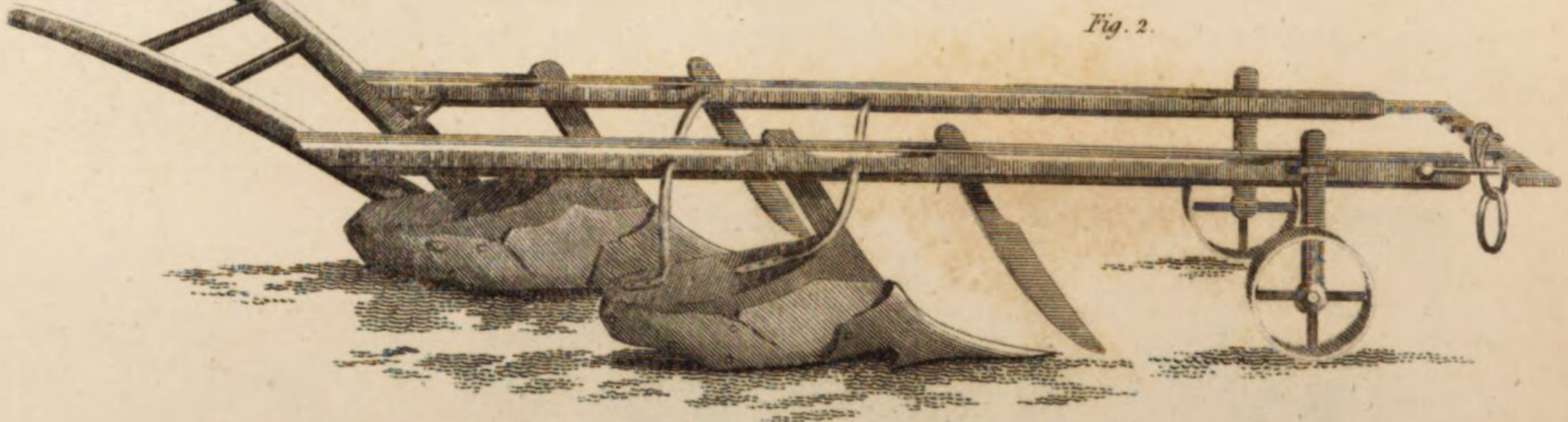


Fig. 2.



3

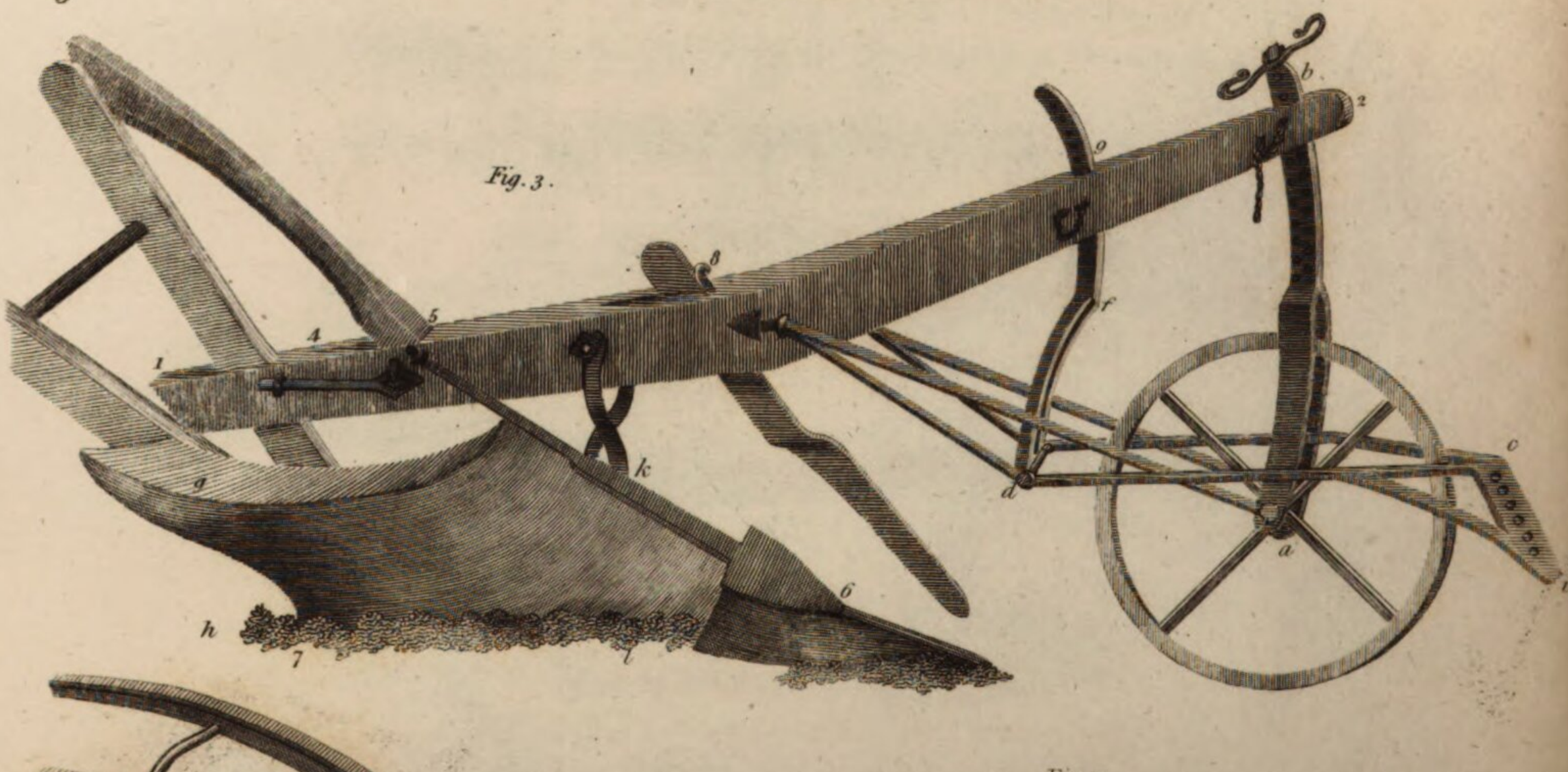


Fig. 3.

Fig. 4.

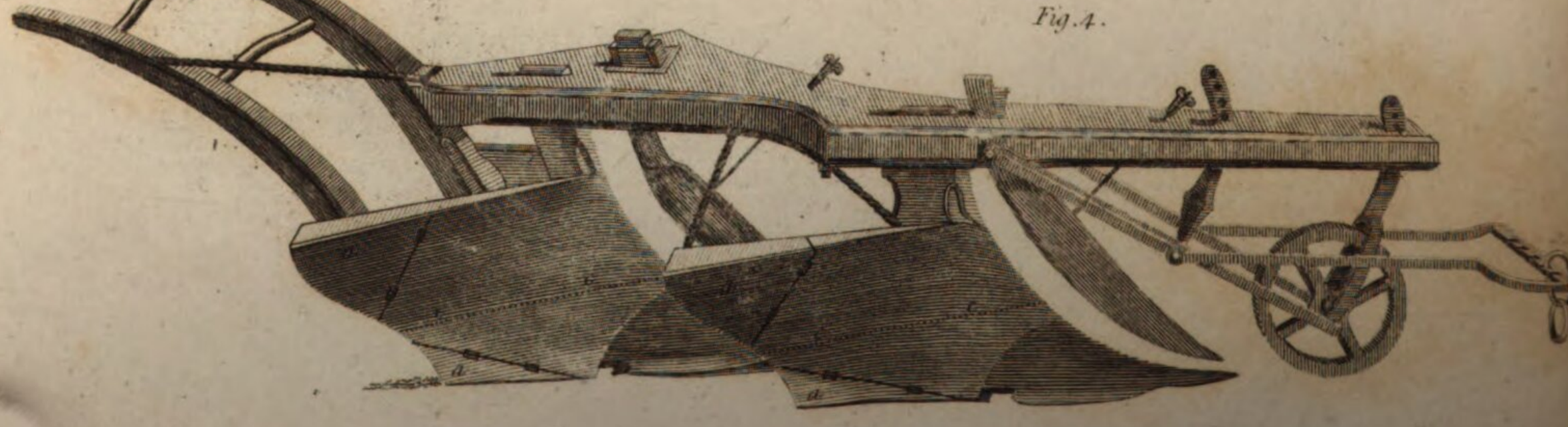


PLATE V.

Double-wheel Ploughs.

[*To face Page* 40.]

Fig. 1. Exhibits a *Double Plough* uſed in Leiceſterſhire. It requires a ſtrong team, but ploughs two acres in the day, and goes ſteady, without holding, from one end of the furrow to the other. It is made by Mr. Hanford, of Hathem in that county, and coſts about 5*l.* 5*s.*

Fig. 2. Is a *Single-wheeled Skim-coultered Plough.* It is an uſeful implement, and capable of being uſed with the common, without the ſkim coulter. It is made as above, and coſts about 3*l.* 13*s.* 6*d.*

At *Fig.* 3. is ſeen an *Improved Wheel Plough*, invented by Mr. Tugwell;

		Ft.	*In.*
The different dimenſions of which are: from 1 to 3	—	6	0
3 to 4	—	3	8
3 to 5	—	4	3
5 to 6	—	2	5
7 to 6	—	2	8
1 to 3	—	1	5
1 to 8	—	2	10
1 to 9	—	4	8
Heel to tuck hole of ſhare	—	2	6½
Tuck hole to point of ſhare	—	0	8½
a to b	—	2	4
d to e	—	2	5
c to d	—	1	4
d to e	—	2	5
Diameter of wheel	—	1	9
d to f	—	0	11
g to h	—	0	10½
e to i	—	1	3½
k to l	—	0	9
Breadth at heel	—	0	9
Breadth of fin	—	0	7
Top of beam at the heel to ground	—	0	8½
Mould board projects at top more than breadth at heel	—	0	6

Fig. 4. Repreſents a two-furrow wheel plough, invented and recommended by Lord Somerville, particularly where deep ploughing is not required, and where expenſive teams are kept, as

performing double the work of other kinds. *a a*, the moveable parts of the mould boards attached to the fixed parts by means of flat hinges, thin flexible plates of tempered ſteel or hard hammered iron, ſo as to admit of being ſet to form different inclinations with them. This is effected by means of ſcrews paſſing from the inſide behind theſe moveable parts, but which are not ſeen in the figure. Theſe ſcrews are ſo contrived as to keep the moveable pieces in any poſition, according to the nature of the work, ſo as to lay the furrow-ſlice more or leſs flat. The parts of the mould plates marked with the dotted lines *c c*, as moſt liable to wear, ſhould be twice the thickneſs of the others, to laſt as long as the reſt of the plough.

IMPROVED WHEEL PLOUGHS.

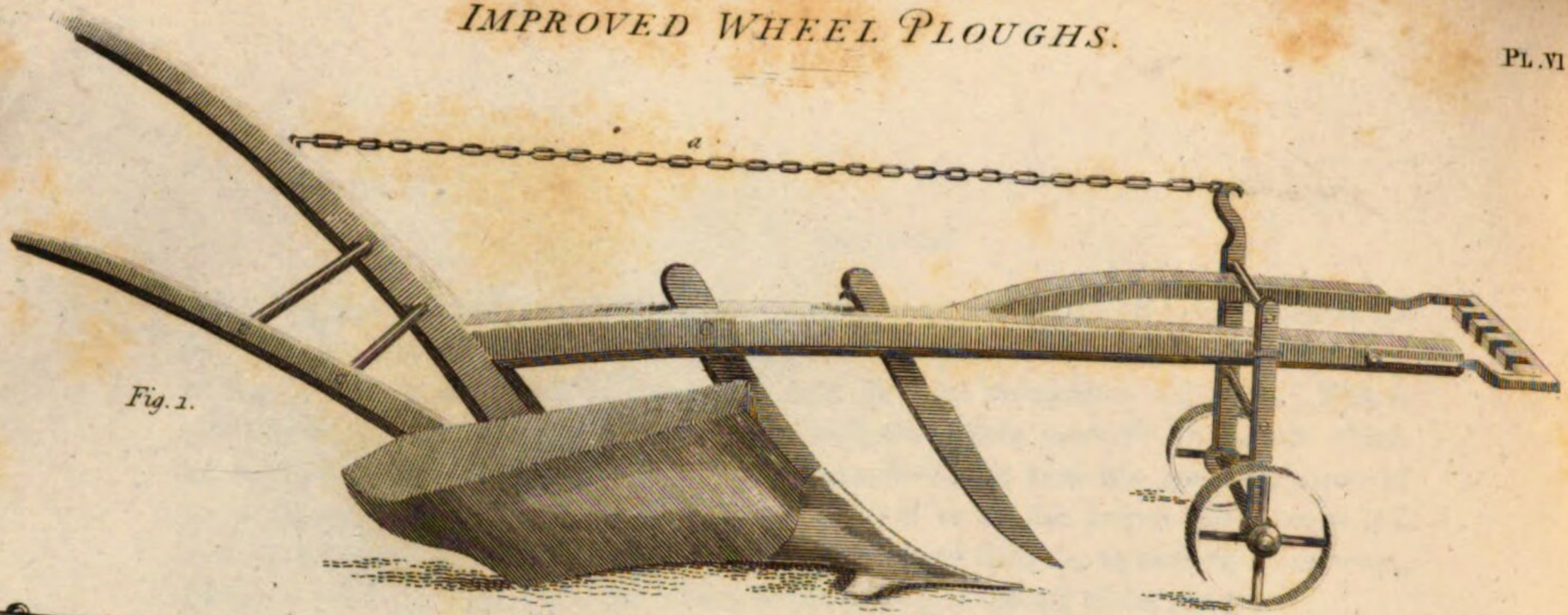


Fig. 1.

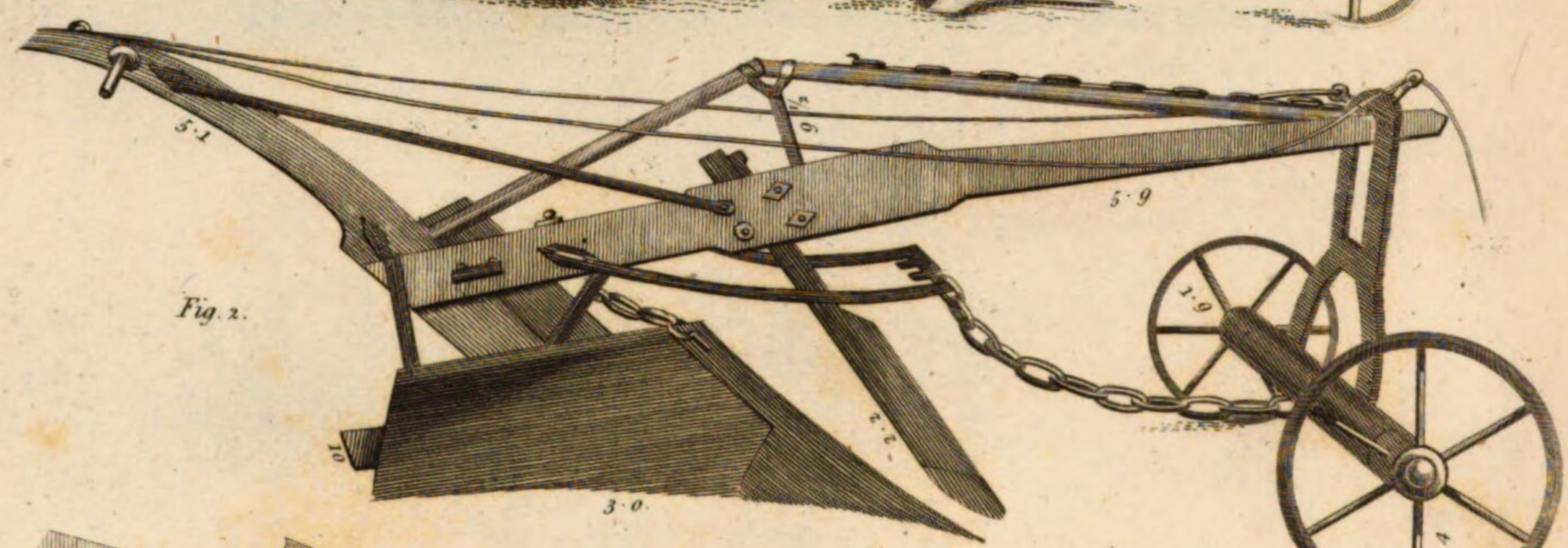


Fig. 2.

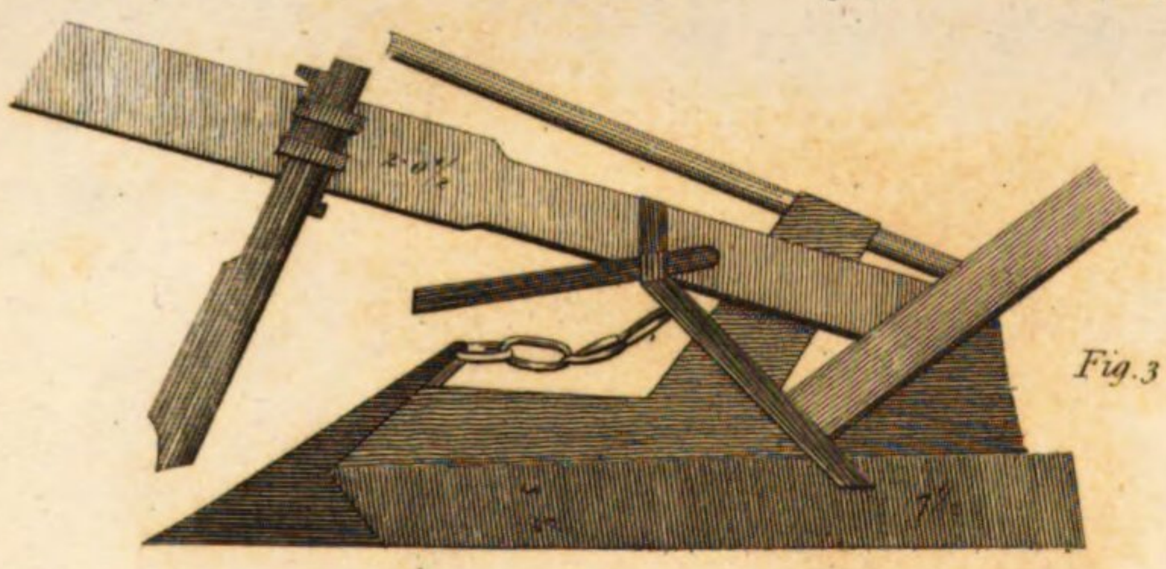


Fig. 3.

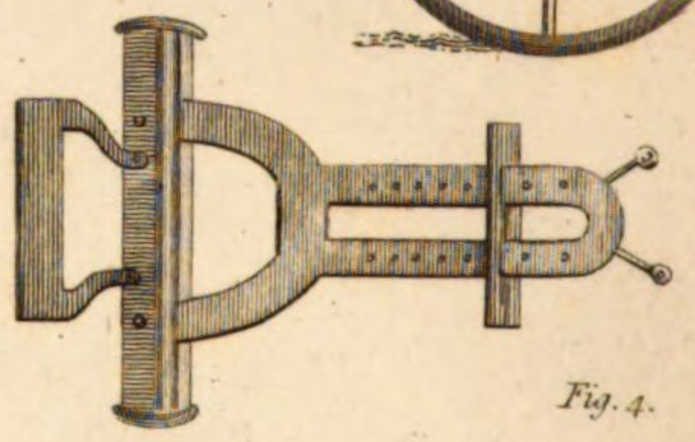


Fig. 4.

Fig. 5.

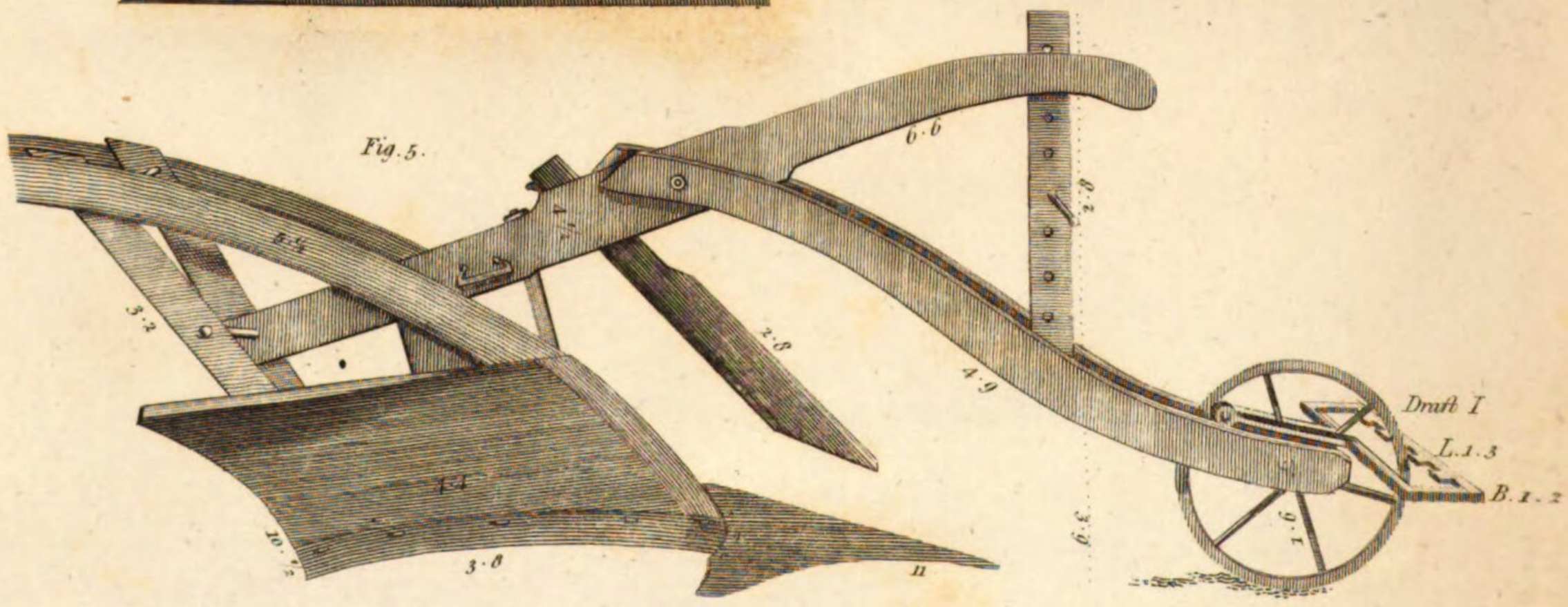


PLATE VI.

Improved Wheel Ploughs.

[*To face Page* 40.]

At *Fig.* 1. is repreſented an improved *two-wheel plough* uſed in the Midland diſtricts: *a* the check-chain to pull up the wheels in opening ridges or clearing furrows. It is made by Mr. Handford in Leiceſterſhire, and coſts, with a double ſet of ſhares, about 3*l.* 3*s.*

Fig. 2. Exhibits a *wheel-plough* uſed in Suſſex for light ſoils. It is uſually drawn by two horſes abreaſt, directed by the holder by reins from the handle, and works ſteadily, diſpatching much work. Ploughs of this ſort are made by Wingham of Nut Bourn, near Chicheſter.

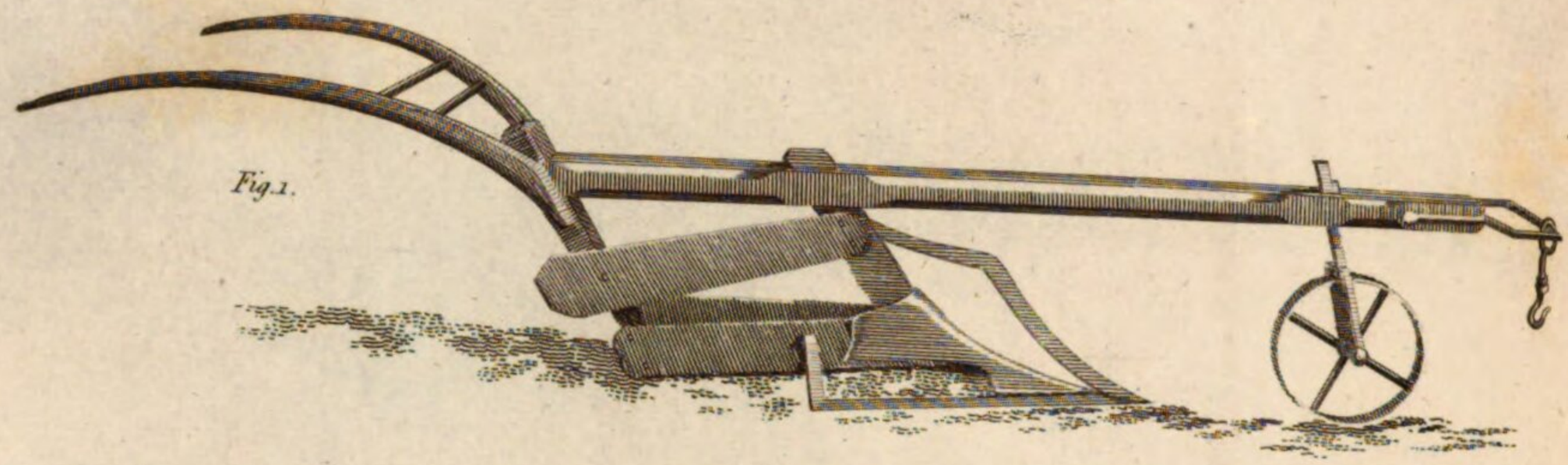
At *Fig.* 3. is a back and ſide view of the ſame plough.

Fig. 4. Explains the manner of fixing the wheel and draught.

Fig. 5. Repreſents another *wheel-plough* employed in hard ſoils, with three or four horſes ſingle or abreaſt. It is found uſeful in doing a great extent of work in the day.

DRAINING PLOUGHS.

Fig. 1.



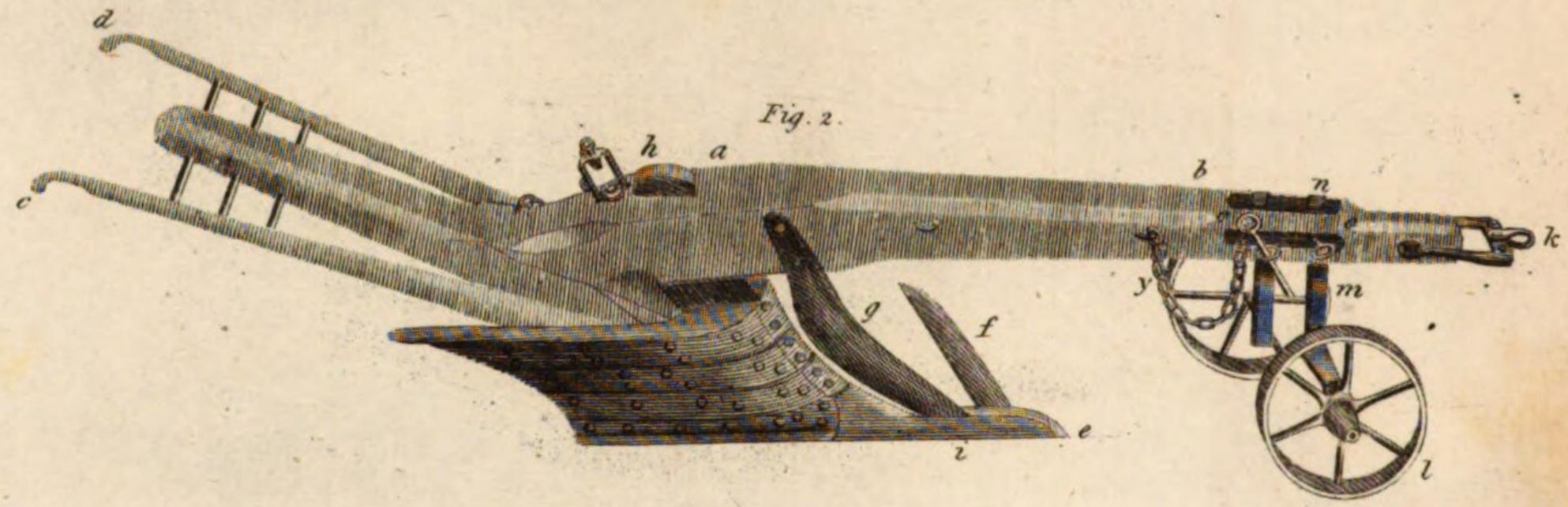


Fig. 2.

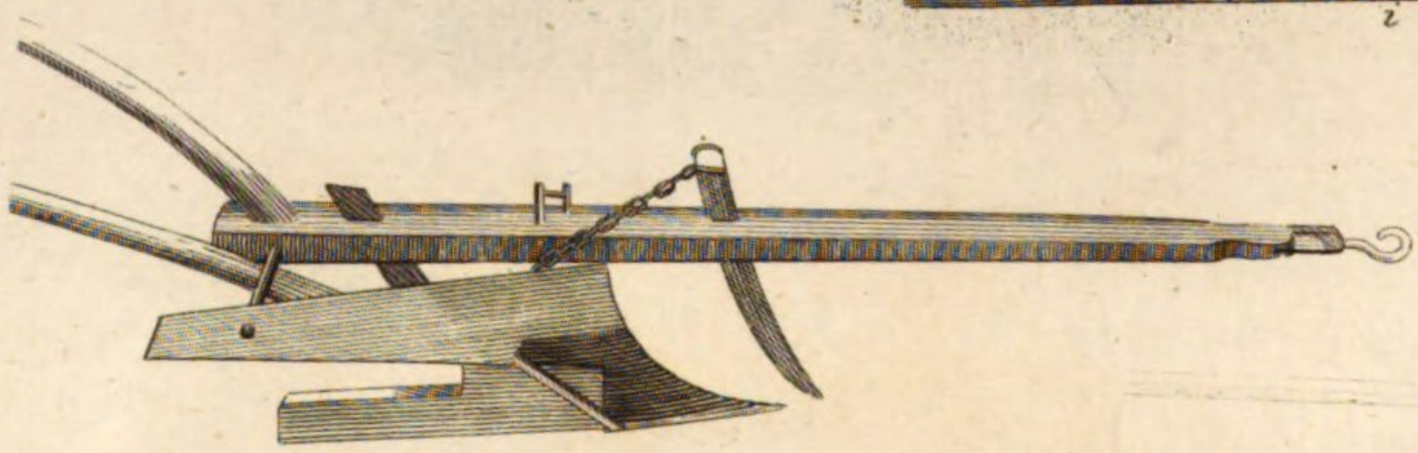


Fig. 3.

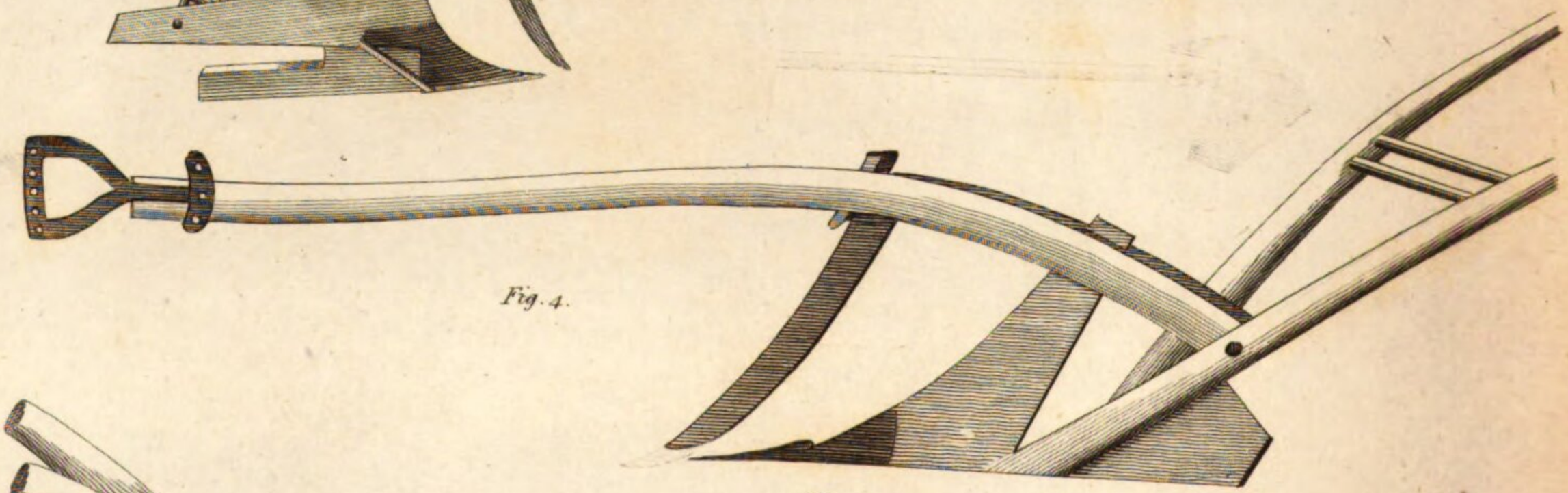


Fig. 4.

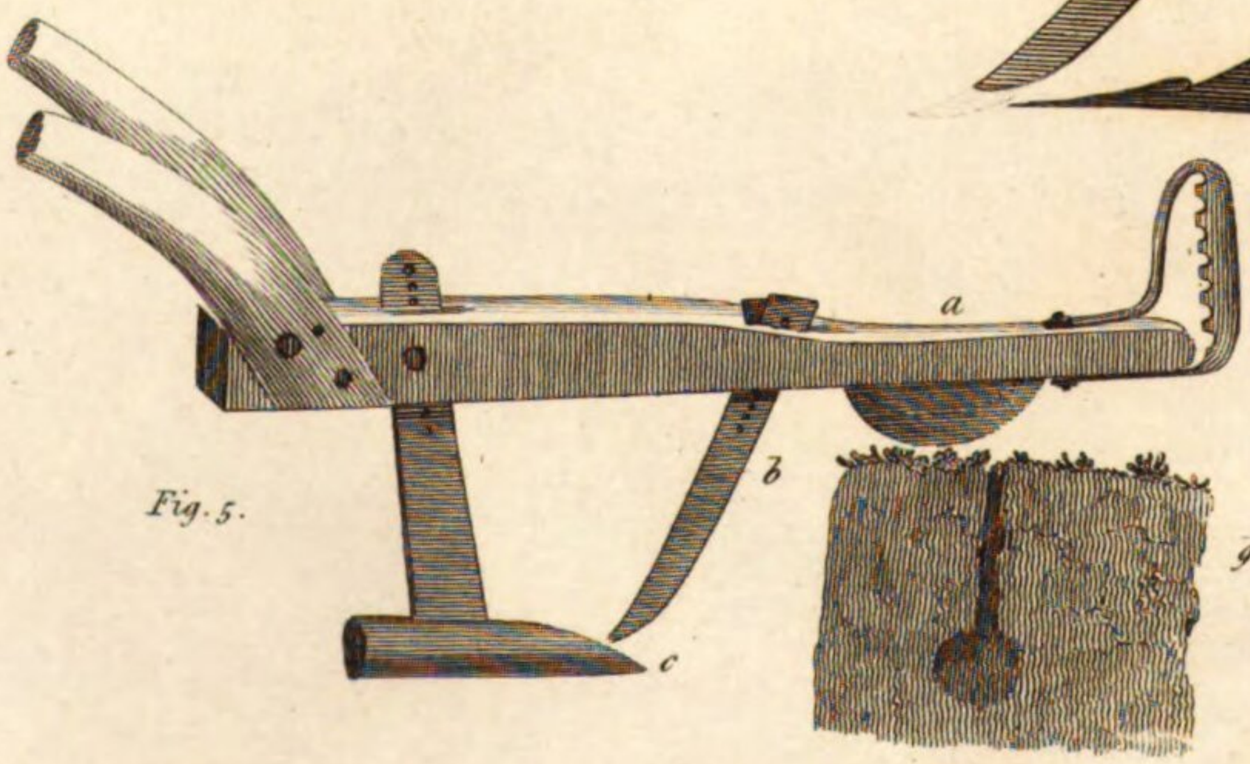
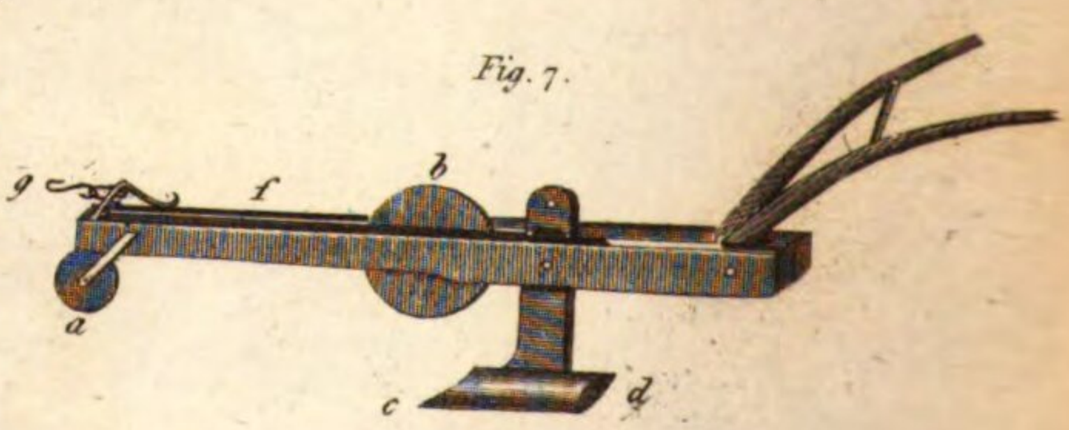


Fig. 5.

Fig. 6.

Fig. 7.



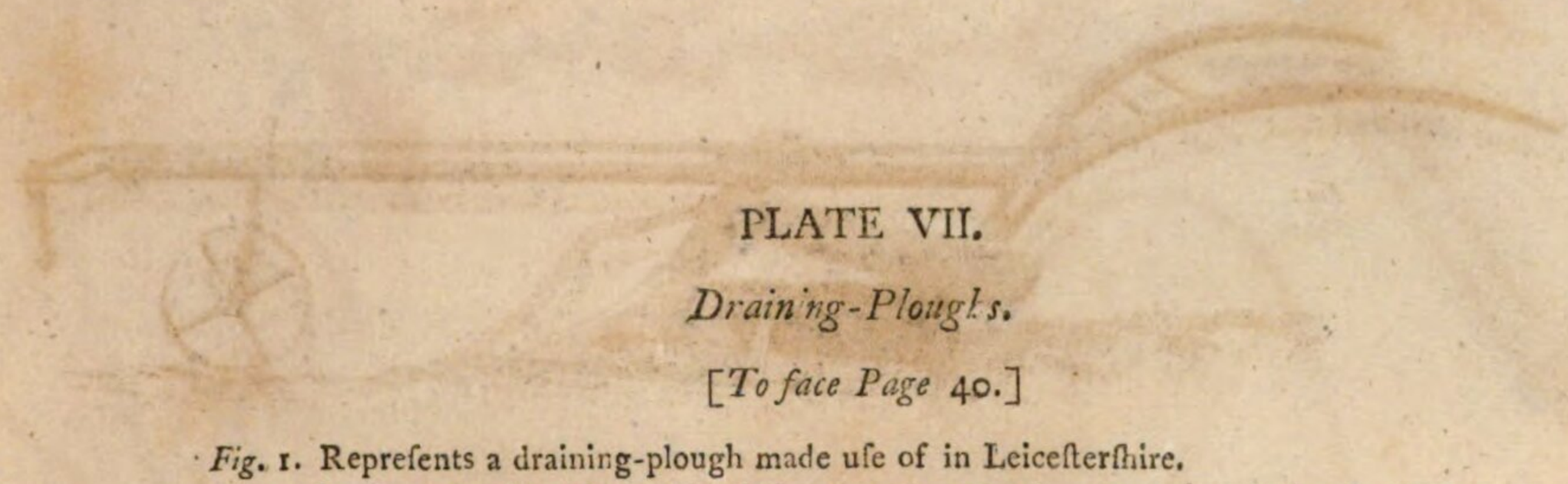


PLATE VII.

Draining-Ploughs.

[*To face Page* 40.]

Fig. 1. Repreſents a draining-plough made uſe of in Leiceſterſhire.

Fig. 2. Is the repreſentation of a *drain- or gutter-plough* recommended by the Duke of Bridgewater; in which *a b* is the beam; *c d* the handles; *e* the ſhare or ſock; *f* the coulter or firſt cutter of the ſod, fixed to the ſhare; *g* the other coulter, or ſecond cutter, which ſeparates the ſod from the land, and directs it through the ſpace or opening between *f* and *g*; this coulter is connected with the ſhare and beam; *h i* the ſheath; *k* the bridle or muzzle to which the ſwingle tree is attached; *l m* two wheels of caſt iron, which may be raiſed or lowered by ſcrews at *n* preſſing upon the flat irons *o o*, to which the axis of each wheel is fixed. Theſe wheels regulate the depth which the ſhare is to penetrate into the earth; *p* a chain with an iron pin to move the ſcrews at *o*.

It has been found uſeful in forming gutter-drains on graſs lands where the ſoils are of a retentive nature. The power of ſix horſes is required in drawing it in ſoils that have not been drained before. But in opening the old gutters four horſes are ſufficient.

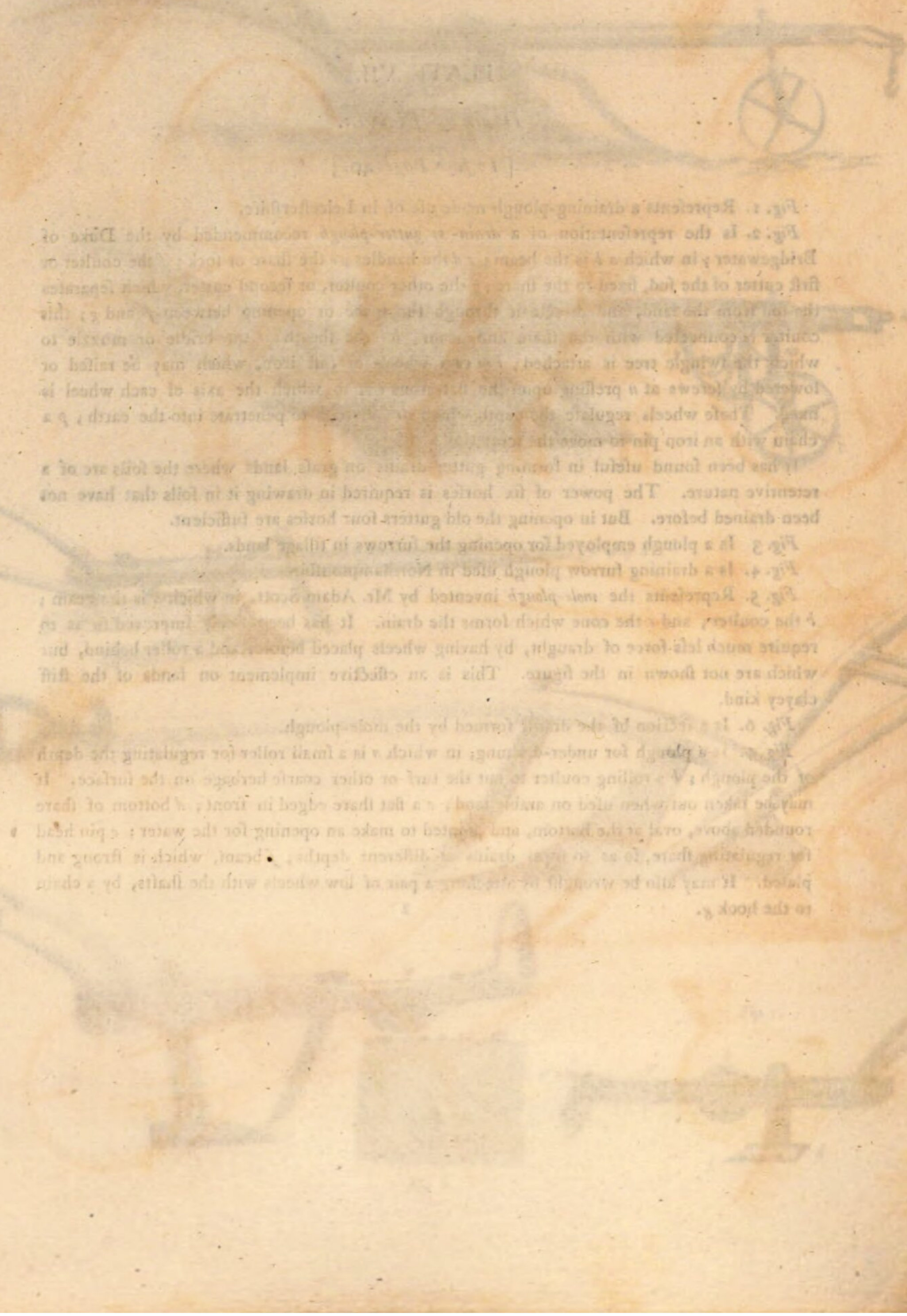
Fig. 3 Is a plough employed for opening the furrows in tillage lands.

Fig. 4. Is a draining furrow plough uſed in Northamptonſhire.

Fig. 5. Repreſents the *mole-plough* invented by Mr. Adam Scott, in which *a* is the beam; *b* the coulter; and *c* the cone which forms the drain. It has been lately improved ſo as to require much leſs force of draught, by having wheels placed before, and a roller behind, but which are not ſhown in the figure. This is an effective implement on lands of the ſtiff clayey kind.

Fig. 6. Is a ſection of the drain, formed by the mole-plough.

Fig. 7. Is a plough for under-draining, in which *a* is a ſmall roller for regulating the depth of the plough; *b* a rolling coulter to cut the turf or other coarſe herbage on the ſurface. It may be taken out when uſed on arable land; *c* a flat ſhare edged in front; *d* bottom of ſhare rounded above, oval at the bottom, and pointed to make an opening for the water; *e* pin head for regulating ſhare, ſo as to form drains at different depths; *f* beam, which is ſtrong and plated. It may alſo be wrought by attaching a pair of low wheels with the ſhafts, by a chain to the hook *g*.



DRILL MACHINES

Fig. 1.

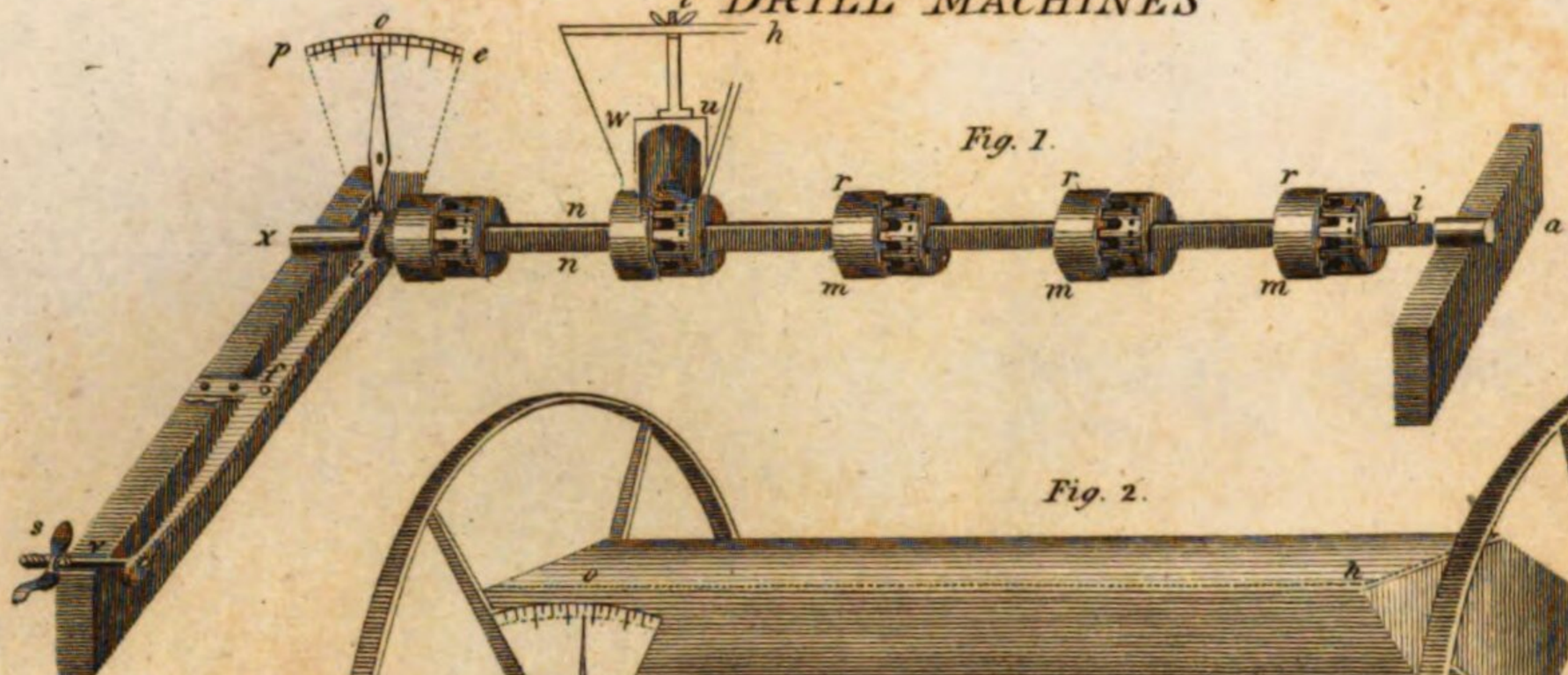


Fig. 2.

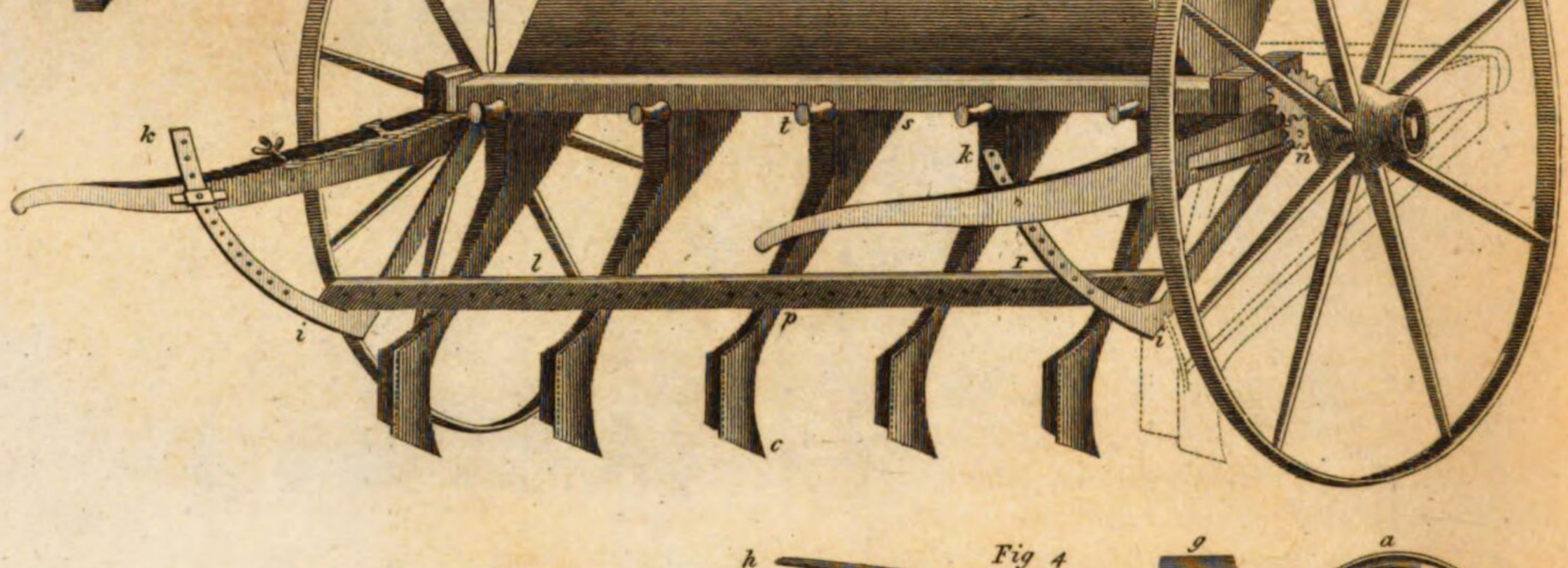


Fig. 4

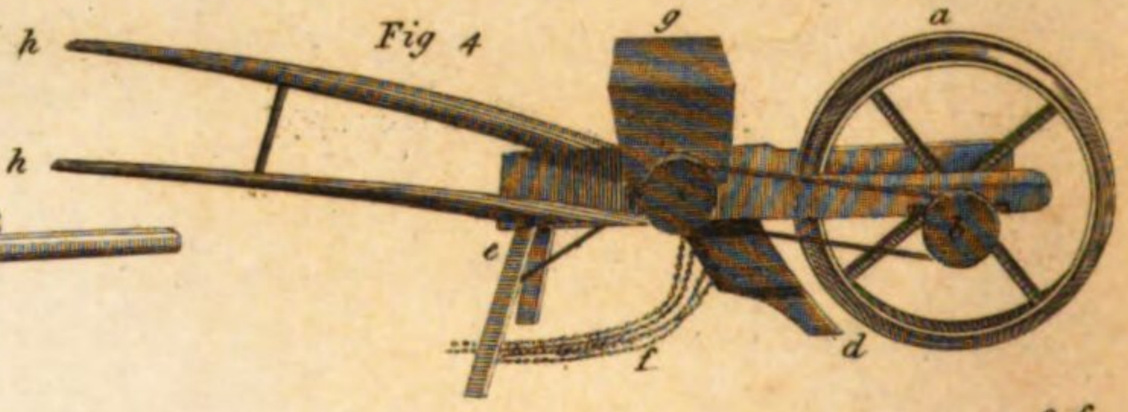


Fig. 5.

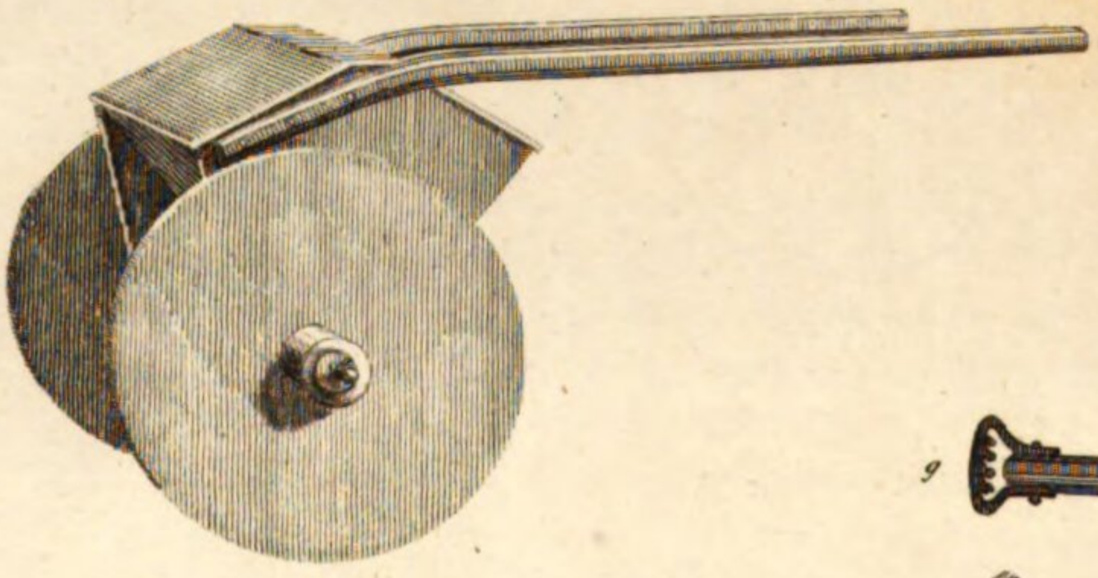


Fig. 3.

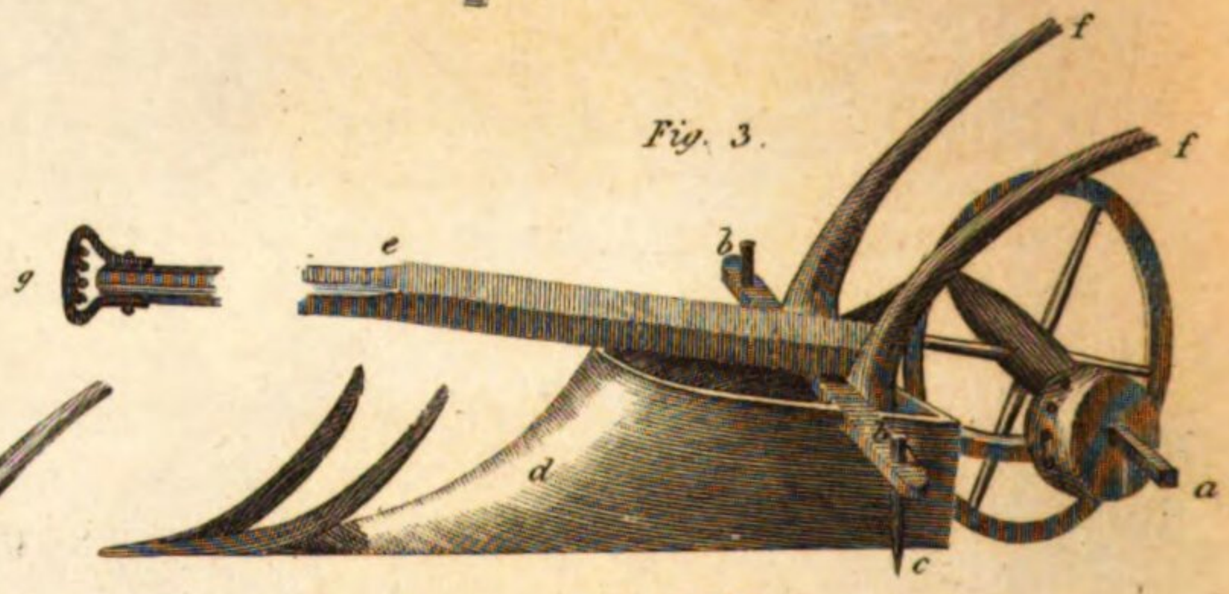


Fig. 6

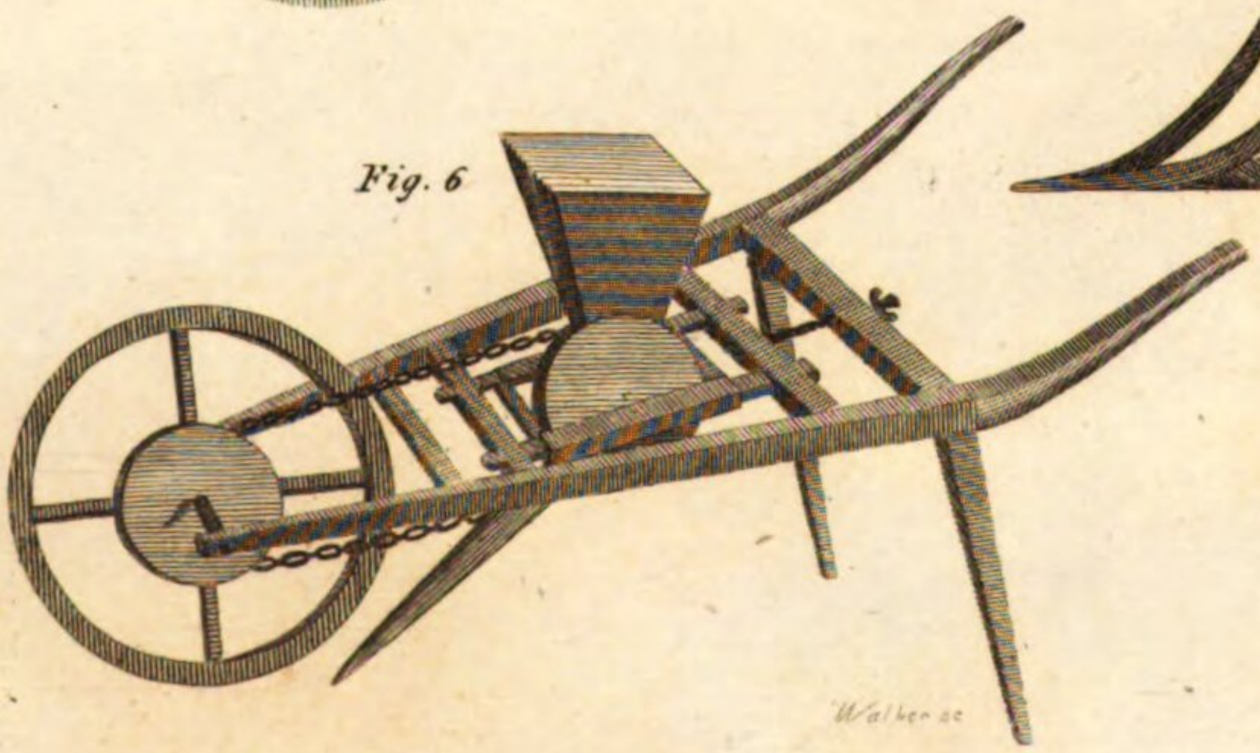


Fig. 7.

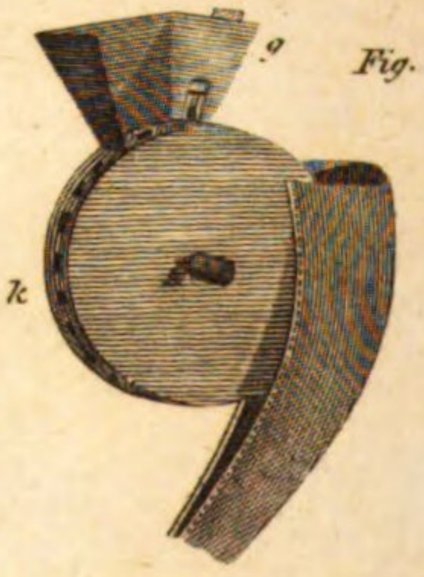


PLATE VIII.

Drill Machines.

[*To face Page* 40.]

Fig. 1. Repreſents the inſide part of an uſeful drill machine, by which the quantity of ſeed is regulated. *a. x* an iron axle, 1 or $1\frac{1}{4}$ inch ſquare, upon which are fixed, at 9 or 10 inches diſtance, five, ſix, or more, braſs fluted cylinders, the flutes being rather more than a ſemi-circle $\frac{4}{8}$ of an inch diameter, or $\frac{5}{8}$ wide and $\frac{6}{8}$ deep. *r. m* are hollow cylindrical rims of hammered iron, which have ſegments turned down at right angles, to fit exactly the flutes of the braſs cylinders; the cavities of which are increaſed or diminiſhed by the ſegments of the iron cylindrical rims ſliding backwards or forwards in the flutes. This is performed in all the cylinders at the ſame time, by a rectangular ſpace (*n*) being made in the braſs cylinders, through which paſſes a ſtraight piece of iron *i. n*, moving on friction wheels at *i*, and faſtened to the plates at *l. k*, and alſo to the cylindrical rims *r. m*. *l. v.* is a lever, the fulcrum of which is *f*, and moved by a ſcrew S, paſſing through the frame at V. The end at *l. k* is forked, and made to fit exactly the ſides of the collar or plates of iron *i. k*. By turning the ſcrew S, the lever moves the whole of the rims at once, and the cavities are increaſed or diminiſhed at pleaſure: this is done with the greateſt facility and readineſs, even while the machine is going and at work; which is frequently neceſſary, where the land varies conſiderably in quality, upon different parts of the ſame ridge: and almoſt inſtantaneouſly, to ſow any kind of grain, and in any proportion; which is ſhown upon the ſcale *e. o. p*, by the index *k. o* fixed to the end of the lever at *k*.

Fig. 2. Is a view of the machine when ready for work. The coulters and ſpouts may be hung differently, as repreſented by the dotted lines, and which is probably the better mode for hilly lands. When employed for ſowing turnips, the large hopper is taken off, and a ſet of ſmall ones fixed upon the half-egg cavities at the end of the braſs cylinders: the quantity is regulated by a tongue ſcrewing up and down.

This machine was invented by Mr. Bury, and deſcribed in the Northumberland Report.

Fig. 3. A drill plough very uſeful in ſowing turnips, invented by Mr. Mure. *a* the ſpindle on which the ſeed-box is fixed; *b b* the croſs piece in which the drill coulter *c* is faſtened; *d* the mould board; *e* the beam; *f f* the handles; *g* the copſe by which it is drawn.

Fig. 4. Is the repreſentation of a turnip-drill, invented by Mr. Knight. *a* the iron wheel running on the edge formed by two concave ſides, makes the groove for the ſeed; *b* a wheel moving on the ſame axis with the former, and turning the wheel *c* by a ſtrap, gives out the ſeed. By having different ſizes of wheels, *d. b*, more or leſs ſeed is ſown as they increaſe or diminiſh the rapidity of *c*. *d* the tube through which the ſeed paſſes into the channel formed by the iron wheel; *e* feet of the implement; *f* ſix lengths of jack chain for covering the ſeed; *g* the ſeed-box; *h h* the handles. There are two holes before the axis of the great wheel for receiving two pieces of cane, which mark the proper width of the intervals between the rows. The angle on the edge of the wheel, and the weight of the implement, are more or leſs acute and heavy according to the ſtrength of the ſoil.

Fig. 5. An implement for drilling turnips, in which the wheels are ſolid. It has been uſed with ſucceſs on ſome of the Duke of Bedford's farms.

Fig. 6. Another drill of the barrow kind, which has been found to anſwer well in ſowing turnips.

Fig. 7. Section of ſeed-box *g* on a large ſcale; the wheel *c* the ſame: it is fixed on axis i_2 which is pierced with holes at K. A ſmall bruſh marked *l* rubs againſt the cylinder to clear out ſeeds that may be detained in the holes.

HORSE HOES.

Fig. 2.

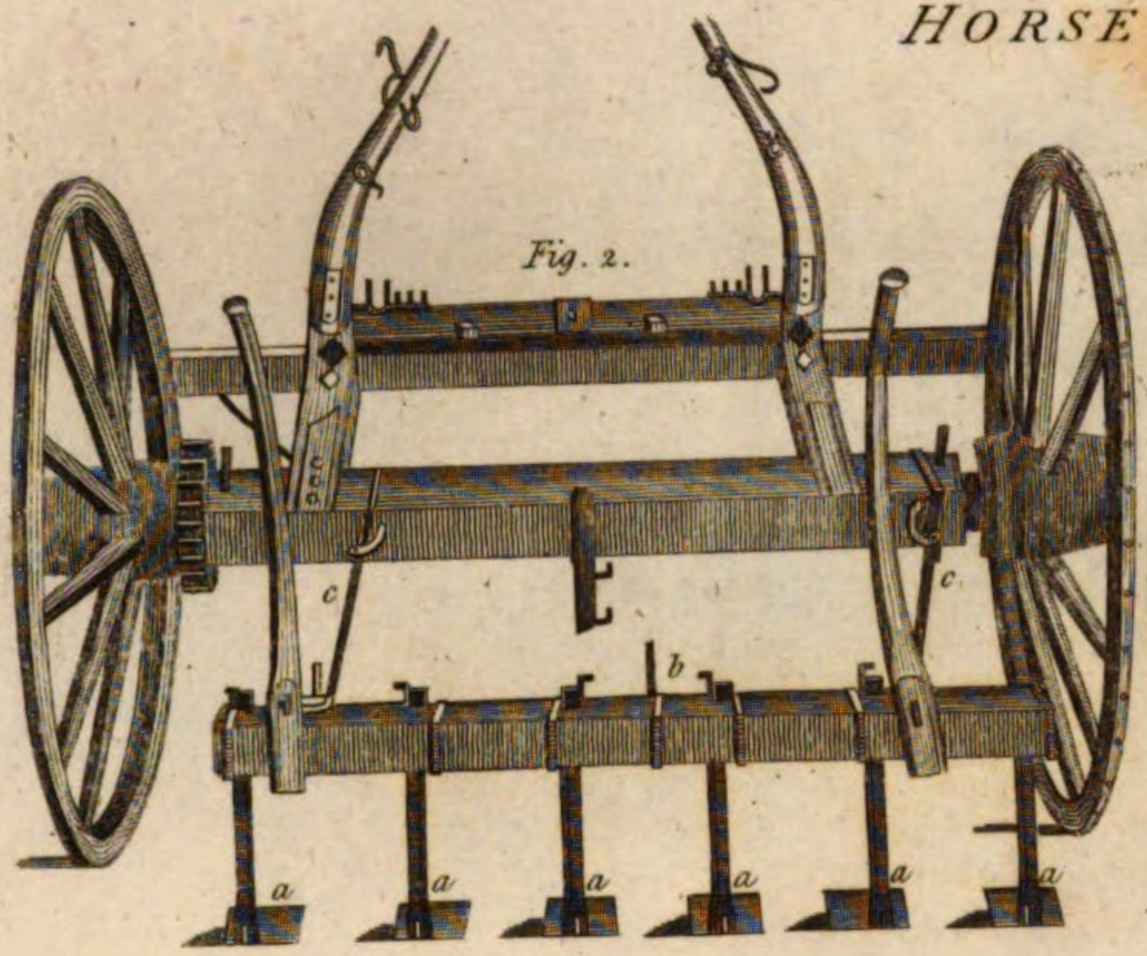


Fig. 1.

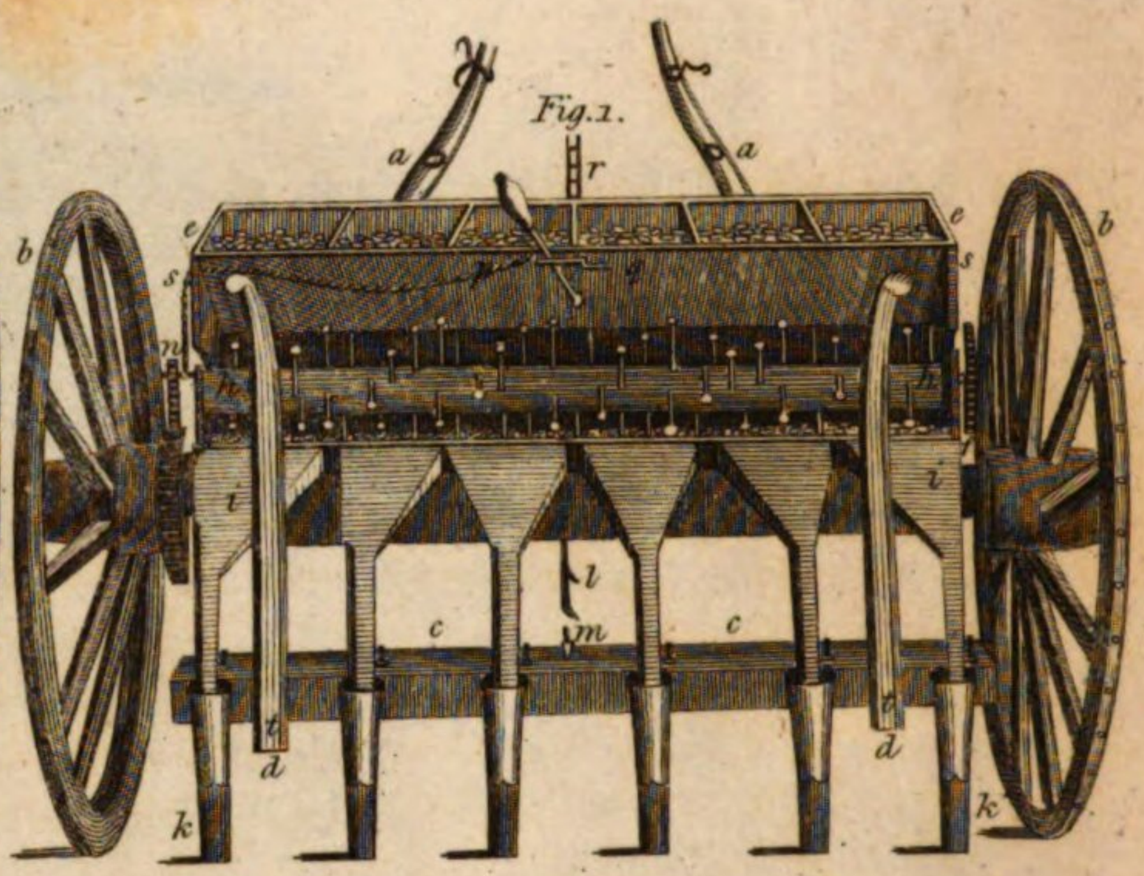


Fig. 3.

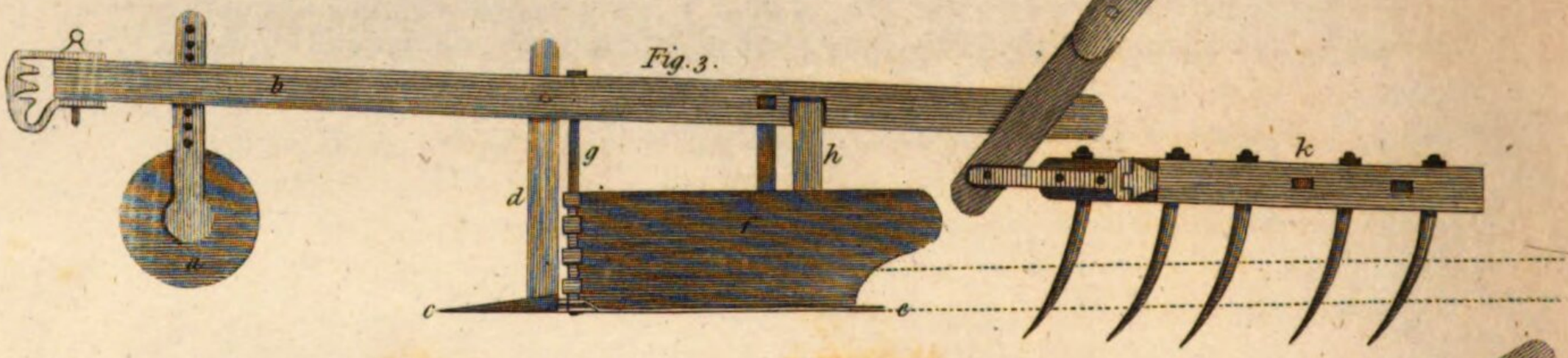


Fig. 4.

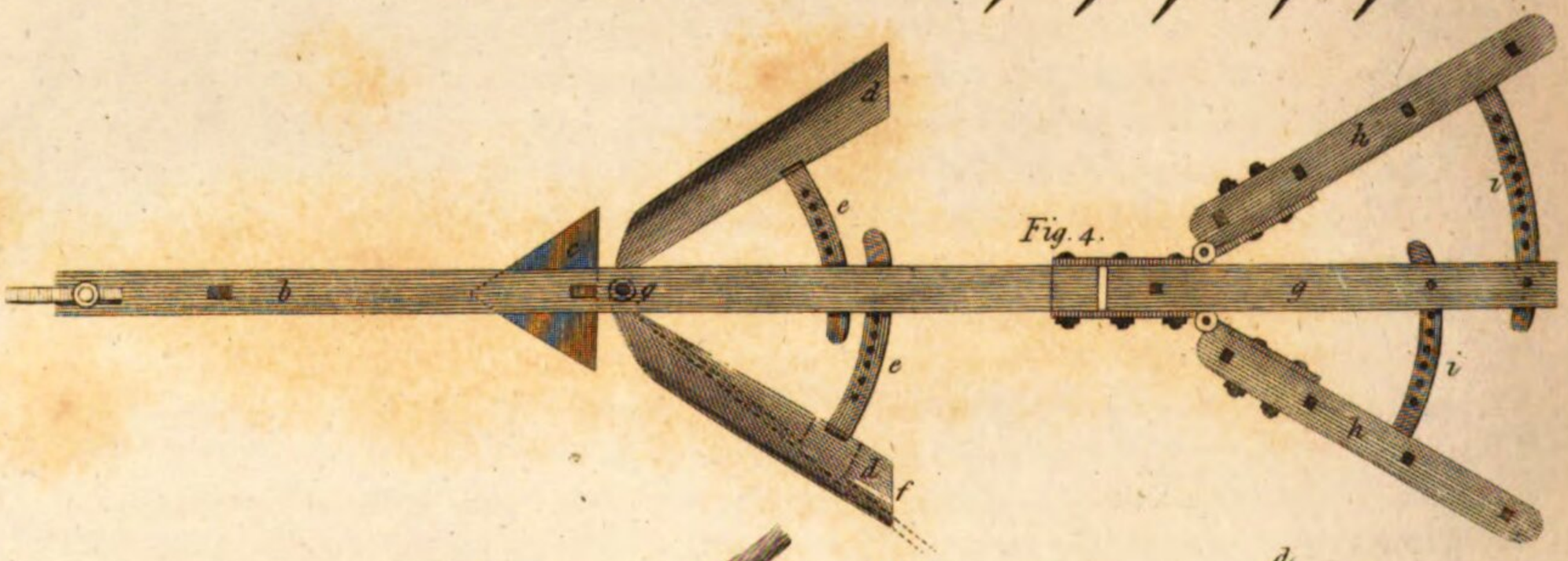


Fig. 5.

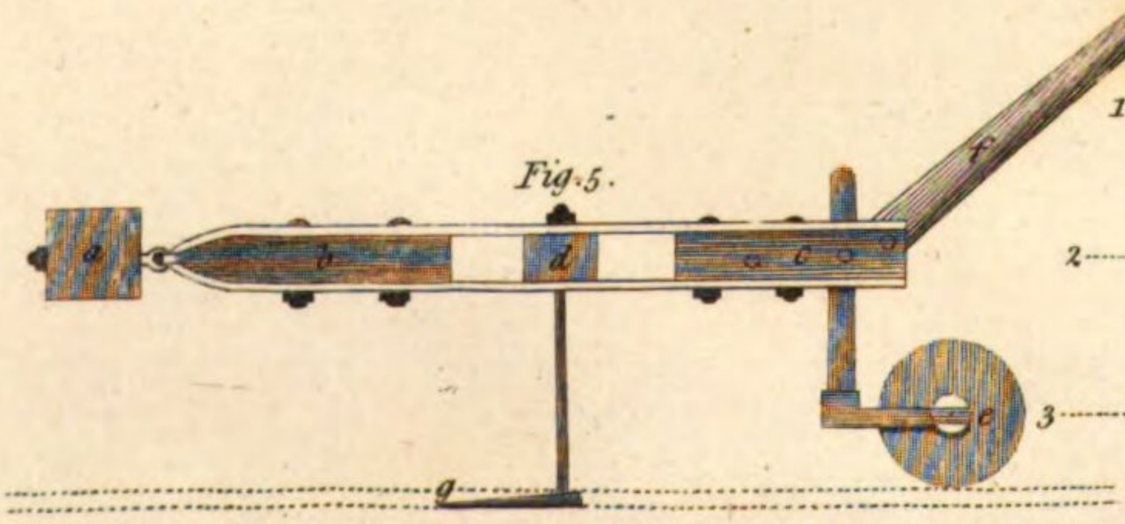


Fig. 6.

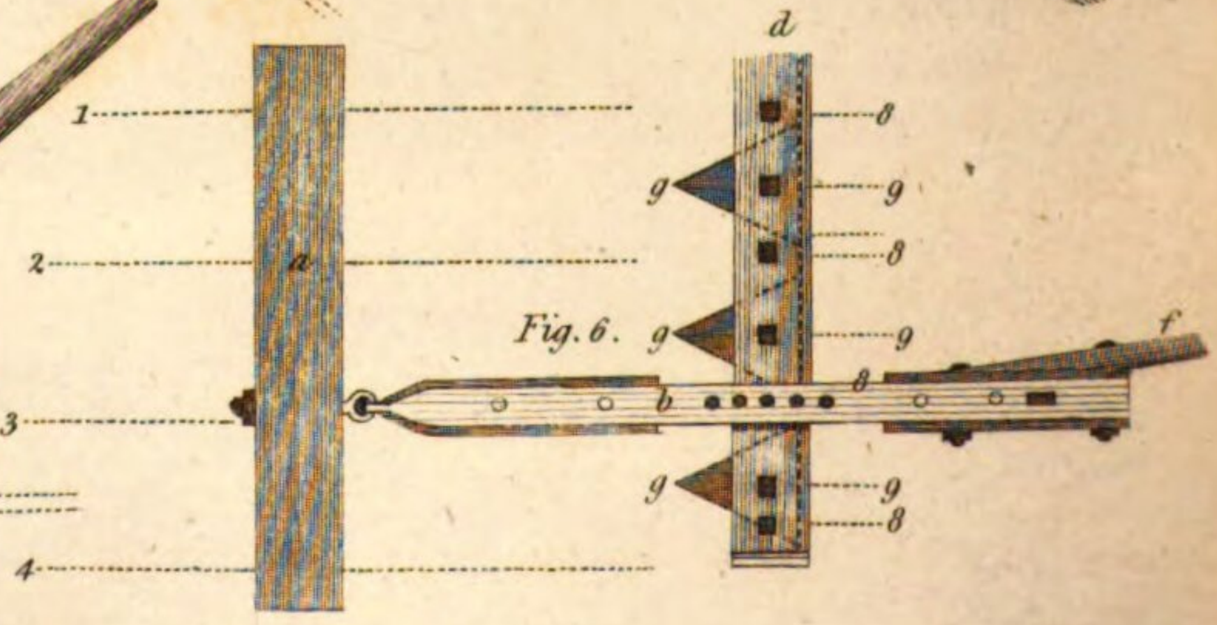


PLATE VIII.

Drill Machine.

[*To face Page* 40.]

Fig. 1. and 2. Repreſent Cook's improved Drill and Horſe-Hoe.

Fig. 1. Is the drill implement; *a a* the ſhafts applied to the axis of the wheels; *b b* the wheels; *c c* the coulter-beam, having holes at proper diſtances for the coulters; *d d* the handles fixed to the coulter-beam, as well as the axis of the wheels, by ſtaples or hooks and eyes; *e e* upper ſeed-box in partitions covered by a lid: *f f* lower ſeed-box in partitions; *g g* ſlides between upper and lower ſeed-boxes, for regulating quantity of ſeed; *h h* cylinder with cups of different ſizes for grain or ſeeds of different ſizes, which take up and drop the ſeed into the funnels *i i*, to be conveyed to the drills in the land *k k*; *l* a hook applied to the axes of the wheels, to receive the links of a chain from the coulter-beam, in order to prevent the tubes from being diſplaced in croſſing gutters, &c. *m* a pin of iron projecting from the coulter-beam, which by being lifted on hook *l* bears the coulters out of the ground in turning, &c. *n* a cog-wheel; *o* another cog-wheel turned by wheel *n*; *p* a lever and ſtring paſſing over a pulley to the axis of the cylinder *h*, by moving which to the notch in ſtaple *q*, the wheel *o* is lifted out of generation with wheel *n*, by which means the diſtribution of ſeed is prevented at pleaſure; *r* an iron bar perforated with holes, by which, with the pin put through the holes, the ſeed-box may be elevated or depreſſed ſo as to keep the lid level in all ſituations; *s s* two ſtaples in the ends of ſeed-box for receiving ſlips of wood with canvass, to prevent the wind interrupting the ſeed, as well as dirt from falling from the wheels into the funnels *i i*.

Fig. 2. Is the ſame implement ſet for horſe hoeing. The ſhafts, axis, wheels, coulter beam, and handles, the ſame as in fig. 1.; the ſeed-box *ee*, the cylinder, *hh*, the funnels *ii*, and the coulters *k k* being removed; and the hoes *aaaaaa* introduced in the place of the coulters, *bc* a guide riſing from the hoe-beam for directing the hoes; *c c* the ſhanks by which the machine is drawn.

Fig. 3. Is a profile of Mr. Amos's expanding horſe-hoe and harrow; *a* the regulating wheel 10 inches in diameter, capable of being adjuſted ſo as that the ſhares may cut at various depths; *b* the beam, ſix feet and a half long and three and a half ſquare; *c* leading ſhare, riveted on ſhaft *d*, is an equilateral triangle of twelve inches; *d* ſhank of ſhare fixed in beam, two inches by half an inch ſquare; *e* edge of expanding ſhares, two feet long and five broad; *f* left hand mould-board, two feet long and ten by ſix inches ſquare, made of light wood, hooked on iron rod *g*, and fixed to ſhank *h* by ſcrew bolt; *g* iron rod paſſing the hind part of leading ſhare, the fore part of expanding ſhares, the mould-board hooks, and the beam in which it is fixed by nut and ſcrew; *h* iron ſhank fixed to the expanding ſhares, kneed at top, where a circular part paſſes the beam, and regulates the width of the expanding ſhare; *i* the handle three feet from the ground line, and the part held by, three feet behind end of beam; *k* profile of ſmall triangular harrow with expanding ſides fixt to end of beam.

Fig. 4. A horizontal view of the expanding hoe and harrow; *b* the beam containing mortices for the ſhanks of the regulating wheel and leading ſhare; *c* leading ſhare, to which expanding ones are fixed by bolt *g*; *d d* expanding ſhares fixed to leading one *c*; *e e* circular

radiuses of ſhanks fixed to inſide of expanding ſhares, which go through beam and regulate width of hoe, fixed to different widths by bolts paſſing through them and beam; dotted lines *f* upper parts of mould-boards; *g* middle bun of expanding harrow three inches ſquare and two feet nine inches long; *h h* expanding buns, three inches ſquare and two feet ſix inches long, fixed to middle one by ſtrong hinges; *i i* two circular iron radiuses fixed in expanding buns, and ſerving to regulate the harrow to any width.

Fig. 5. The profile of a ſix-ſhared horſe-hoe on the principle of the pentagraph, improved by Mr. Amos by the addition of two caſtor-wheels to regulate depth. It moves with eaſe to right or left; *a* a ſection of coulter-bar of drill, to which it is fixed by eye-bolt; *b* piece of aſh three inches ſquare and ſixteen long, narrow before to hook on bolt paſſing coulter-bar; *c* another piece thirteen inches long, fixed between iron bar at twelve inches diſtance by four ſcrew-bolts; the bars are two inches broad, half an inch thick, and forty-one long; *d* ſection of coulter-bar four by three inches ſquare, moveable between pieces of wood and iron bars; *g* ſhare with ſhank ſixteen inches long and one and a half by half inch ſquare, fixed in coulter-bar, being riveted in hind part of ſhare; *e* caſtor-wheel, eight inches in diameter and two thick at centre; *f* handle fixed to piece of wood *c* by two bolts and ſcrews.

Fig. 6. A horizontal view of a ſix-ſhared horſe-hoe; *a* coulter-bar of drill, to which it is fixed in working; *b c* iron bars, between which coulter-bar moves on bolt, in which are holes for ſhifting in different ways; *d* bar in which hoes are fixed; *figs.* 8. and 9. manner of fixing them when rows of corn are eight or nine inches aſunder; *g g g* three ſhares in form of triangle, two fore ſides of which are ſeven inches long, and hind ſide ſix; *f* handle for left ſide fixed to end of ſide frame by two bolts: the numbers 1, 2, 3, 4, repreſent four rows of corn at nine inches apart.

Fig. 7. A horizontal view of coulter thirteen inches long below coulter-bar. There are ſeven, which are uſed in place of hoes in ſtiff ſtony or weedy land.

Fig. 8. A profile of a coulter made ſharp on fore edge in order to operate more eaſily.

Fig. 1.

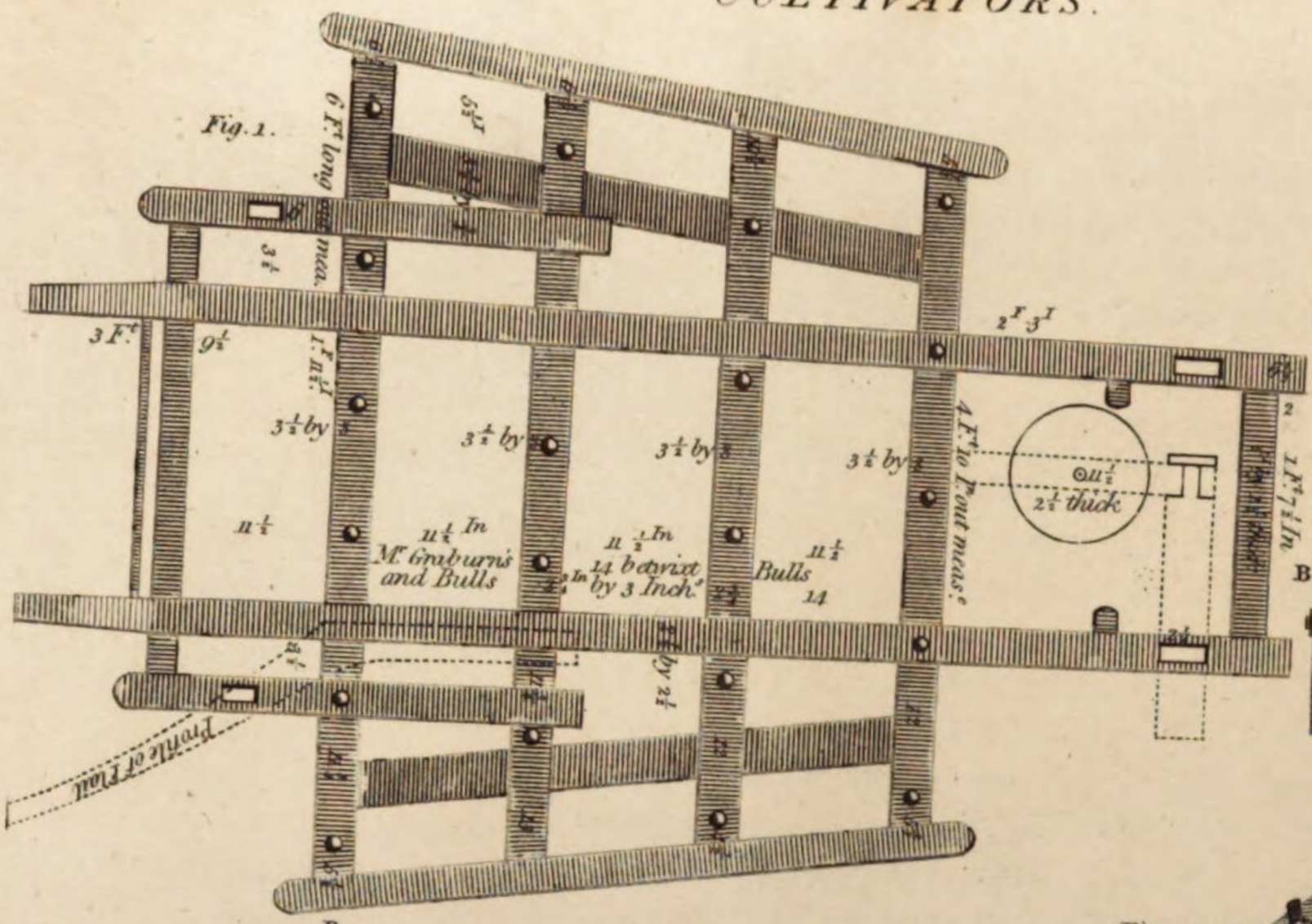
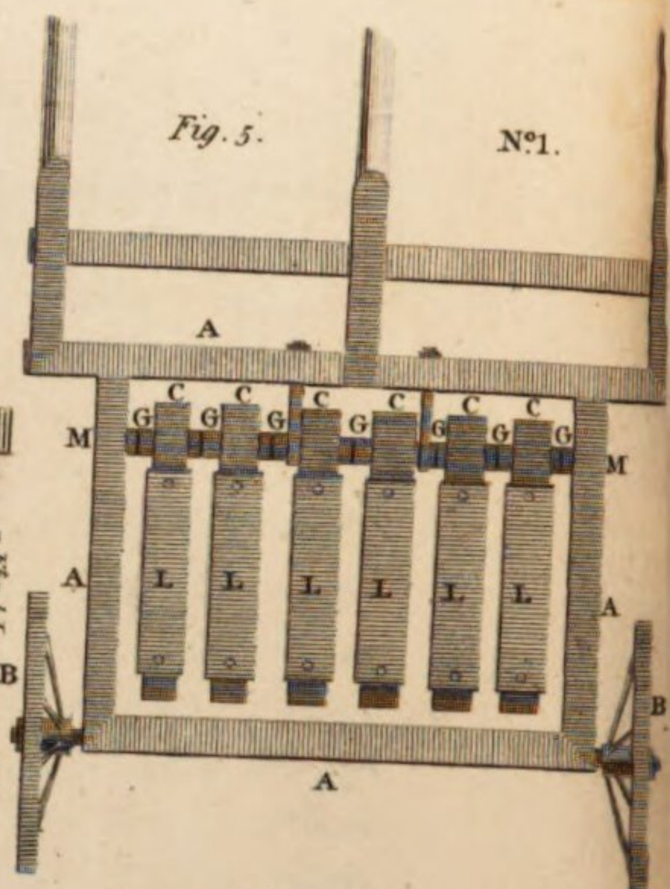


Fig. 5. No. 1.



No. 2.

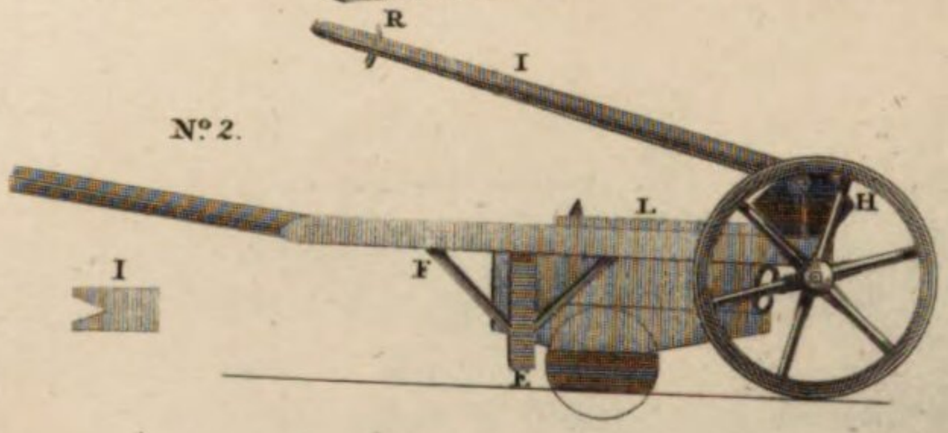
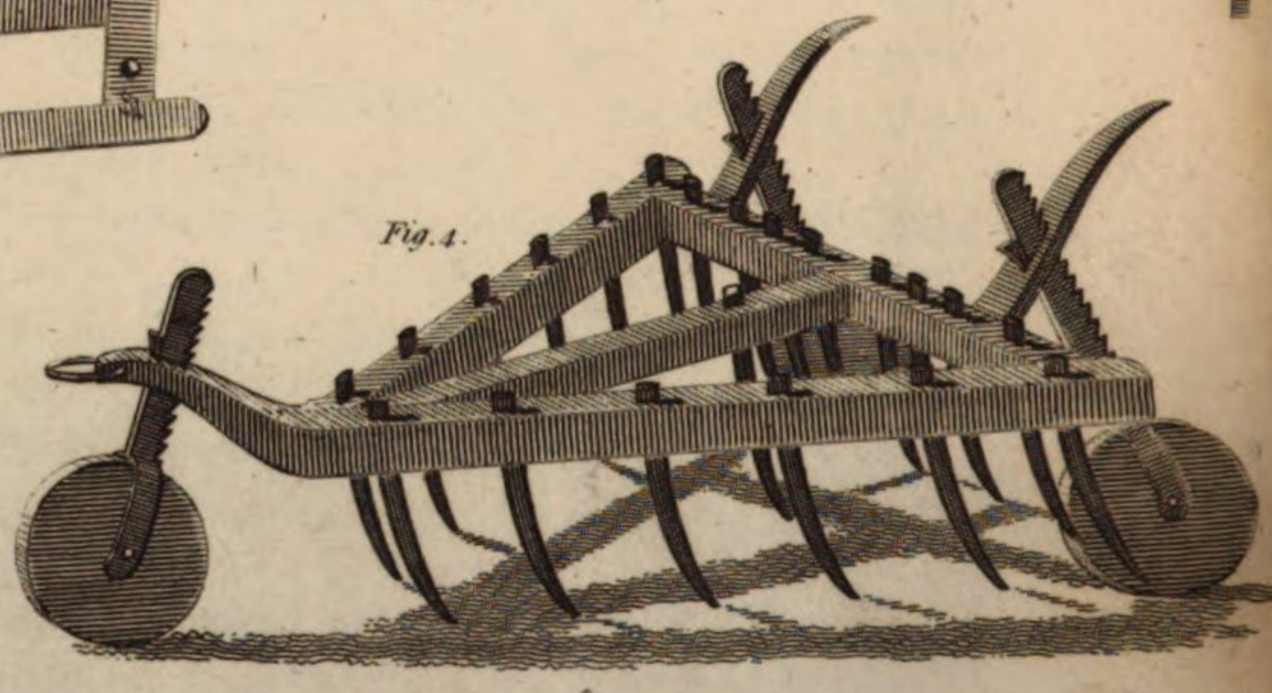


Fig. 4.



No. 3.

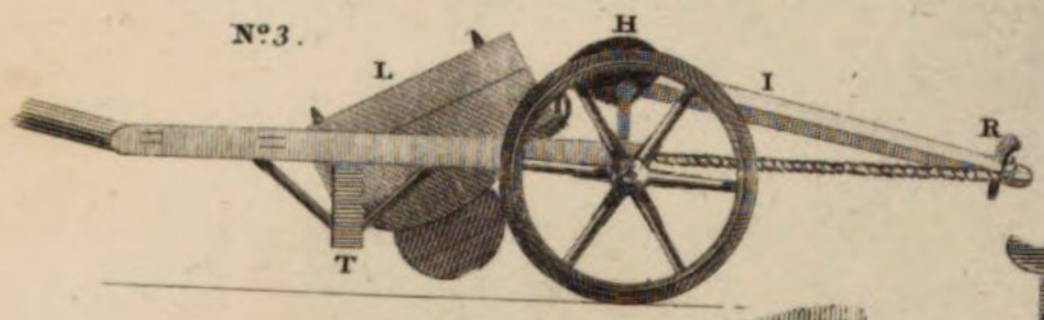


Fig. 2.

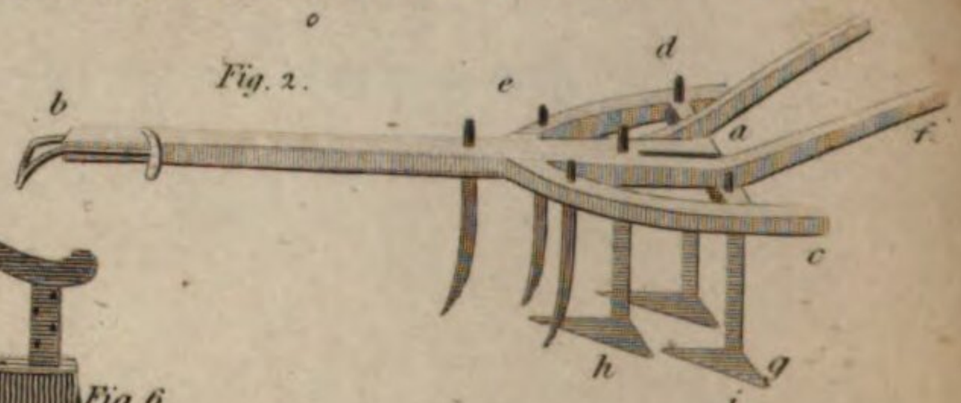


Fig. 7.

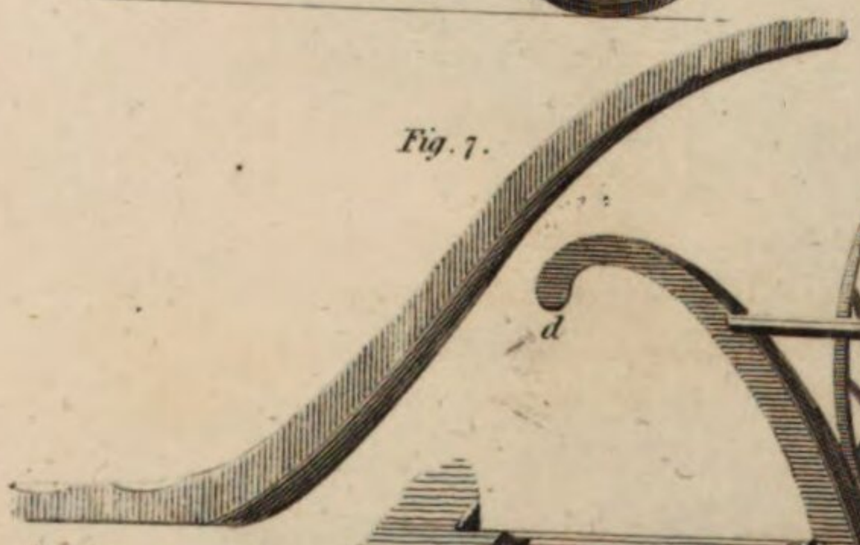


Fig. 6.

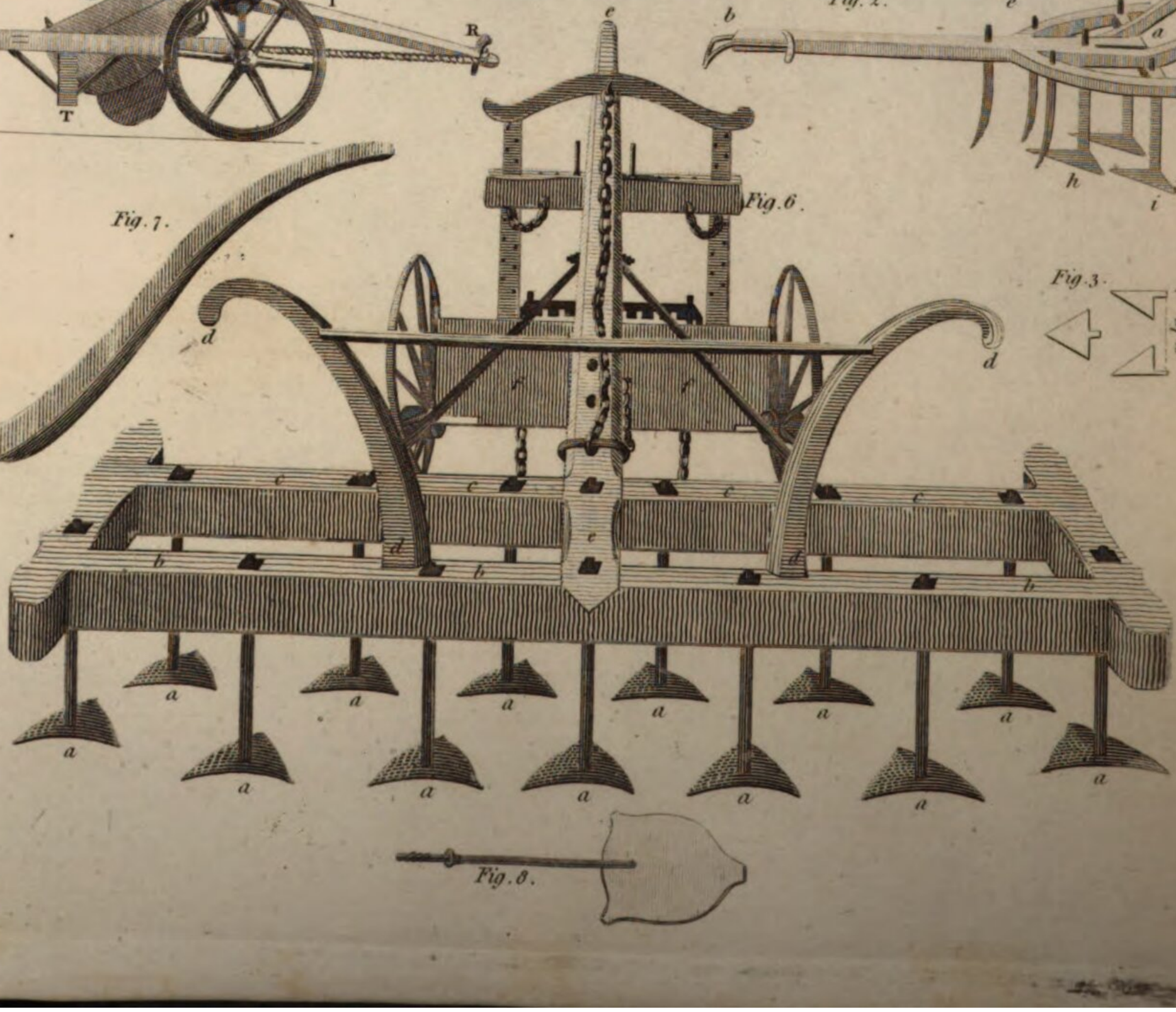


Fig. 3.

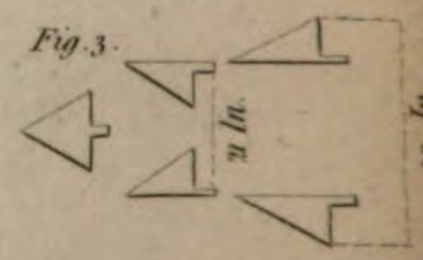


Fig. 8.

PLATE X.

Cultivators.

[*To face Page* 40.]

At *Fig.* 1. is the repreſentation of a *Scuffler* employed with great advantage by Mr. Grayburn in Lincolnſhire, in putting in grain crops on turnip-fed lands after one ploughing. The ſeed is by this implement ſcuffled in, and the neceſſity of a ſecond earth avoided.

Fig. 2. An implement of the ſame kind, that is made uſe of in Northumberland for hoeing bean-crops drilled at thirty inches. It is alſo capable of hoeing and ſtirring ſtrong lands in dry ſeaſons, when the plough cannot be employed. With other proper hoes put into it, the purpoſe of ſcufflers and cultivators, &c. is anſwered in a very cheap and eaſy manner: *a b* the beam five feet in length, and in height at *b* 16 inches; *c e* and *d e* curved lines having a radius of 24 inches from *c* and *d* as centres: *a* to *f* the length of ſtilts 42 inches; the length of the ſhanks of hoes from *g* to under ſide of beam 15 inches; length *g* to *b* 7½ inches; breadth from *g* to *i* 5½ inches: *c e*, *d e* holes in the ſides, and *c d* in the end, for the reception of ſmaller hoes for light ſoils, as to hoe from 18 to 30 inches at once. When made a little wider to take in four hoes, it anſwers well for hoeing wheat drilled at 10 or 12 inches. It is drawn by a ſingle horſe, and coſts only from 30 to 40s.

Fig. 3. Shows the ſizes of the hoes.

Fig. 4. An *Improved Cultivator* with wheels and handles. It is found uſeful in preparing and reducing ſtiff heavy ſoils. From its weight, and the great length of the tines or coulters, it is a very powerful implement.

Fig. 5. Is the repreſentation of a *Sward-cutter*, or implement for cutting tough ſwards in a croſs direction previous to their being broken up by the plough, or before the operation of paring and burning is begun. It is likewiſe uſeful for breaking down and reducing the cloddineſs of tillage lands, when in preparation for different ſorts of crops that require a high degree of pulverization.

Different parts of the machine are repreſented at No. 1. 2. 3.—No. 1. AA, &c, is a ſquare frame 3 feet 4 inches from the fore to the hind part, by 4 feet 3 inches, the breadth of the machine within ſide; the timber (when of fir) 4 inches ſquare, placed on two wheels BB, 3 feet diameter. CC, &c. are ſix ſtrong pieces of wood, called *bulls*, 3 feet long, 5½ inches broad, the thickneſs 6 inches at E, and tapering to 3 inches at F. Into theſe are fixed the cutting wheels, which are iron, 13 inches diameter, ¾ths of an inch thick at the centre, about an inch diameter, for piercing holes to fix the iron axles in; from that they are to be of ſuch thickneſs as will allow the edges to be well ſteeled. The wheels are fixed by two bolts going through the bulls. GG, &c. are hollow pieces of wood, called *thorls*, each 3½ inches long, which incloſe the bolt MM, and keep the bulls CC, &c. at their proper diſtances, but may be made longer or ſhorter at pleaſure, according as the ſward requires to be cut in larger or ſmaller pieces. The iron bolt MM goes through two pieces of wood or iron, PP, 7 inches long, clear of the wood, ſupported by iron ſtays fixed to the frame, and through all the bulls. HH, No. 2. and 3. a cylinder or ſegment of wood, 7 inches diameter, called a *rocking tree*, which goes acroſs

the frame, and moves on the pivots fixed into it, one at each end, ſupported by an iron bolt or piece of wood mortiſed into the frame, 8 inches high, as appears at No. 2. and 3. to which 6 chains or ropes are fixed by hooks, at different diſtances, as you want your cuts, 9, 8, 7, or 6 inches from one another, and are joined to the end of each bull in which the cutting wheels run; ſo that when the rocking-tree is turned about by the lever I, fixed in the middle of it, all the bulls with their cutting wheels are raiſed out of the ground at once, as at No. 3. by which means the machine may be turned without any danger of ſtraining the wheels. LLL, &c. No. 1. 2. 3. are weights of freeſtone, 26 inches long and 6 inches broad; the under one 4 inches thick, the upper one 3 inches thick; weighing about 64 lbs. the under, and 48 the upper; each of them having two holes, through which iron ſpikes, firmly fixed in the bulls, paſs, in order to keep them ſteady. When the ground is eaſily cut, the under ſtone may anſwer; when more difficult, the other ſtone may be added; ſo that every wheel may have 7 ſtone weight upon it, which has been found ſufficient for the ſtiffeſt land and tougheſt ſward the machine has ever been tried on. Weights will anſwer fully better, but are more expenſive. The lever I, No. 2. 3. which ought to be 5 feet long, muſt have a ſliding rope on it, fixed to the back part of the frame; ſo that when the cutting wheels are all taken out of the ground three or four inches, by the rocking-tree's being turned partly round by the lever, the rope may be fixed to it by a loop over the pin R, No. 3. Thus all the cutting wheels are kept out of the ground till the machine is turned; and then, by moving the loop off the pin, it ſlips back towards the frame, and the lever is gently let back to its place, as in No. 2. by which the cutting wheels are put into their former poſture, by the weights fixed on the bulls in which they run. PP, No. 1. a ſmall bolt of iron, with a hook on one end of it, to ſtrengthen the bolt MM, to be hooked on the centre of it, and joined to the frame by a nut and ſcrew. For a ſingle-horſe ſward-cutter (which has only four cutting wheels), a pair of ſhafts are uſed, and may make the two ſides of the frame without any joinings. The width of the frame, in proportion to the double-horſe ſward-cutter, is as four to ſix. One man manages the machine and drives the horſes. He begins his operation by firſt meaſuring off 20 or 30 paces from the machine on each ſide, and there fixing poles. He then cuts the field acroſs, as near at right angles with the ridges as he can.

Fig. 6. An *Extirpator* uſed in Suffolk for the purpoſe of clearing land; which is ſaid to be a very effective implement. In the figure is ſeen a back view of the machine, when put together ready for work: *a* the ſhares, eight inches broad and nine inches long, which are fixed to ſtalks, riſing ten inches. The diſtance between them is eleven inches: *b* the hind ledge, ſix feet long, and about four inches ſquare: *c* the fore ledge, five feet and a half long, four inches ſquare; the diſtance of theſe ledges is twelve inches: *d* the beam, ſeven feet long; its elevation is three feet three inches. See fig. 7. *e* the handles.

Fig. 7. A ſide view of the beam.

Fig. 8. Repreſents a ſhare with its ſtalk.

This implement is capable of being fixed to the wheels, &c. of a common wheel-plough, and made to go ſhallower or deeper in the ſame manner.

COMMON HARROWS.

Fig. 1

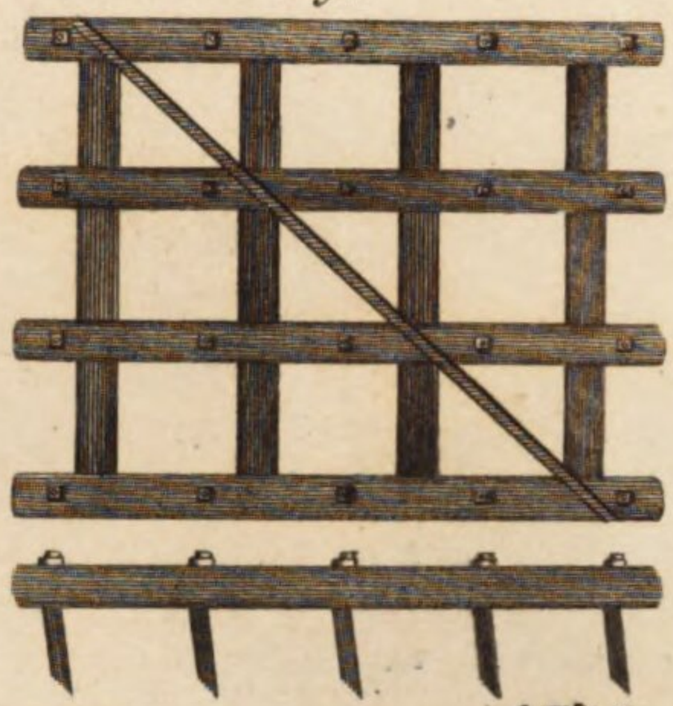


Fig. 2

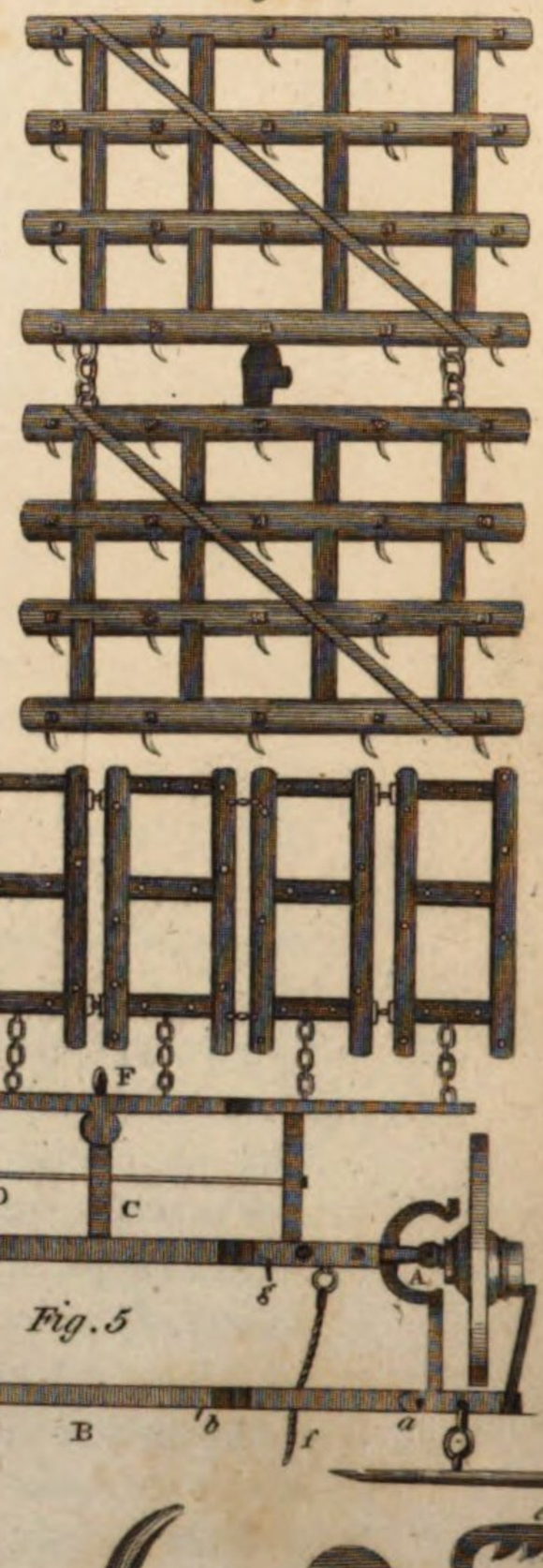
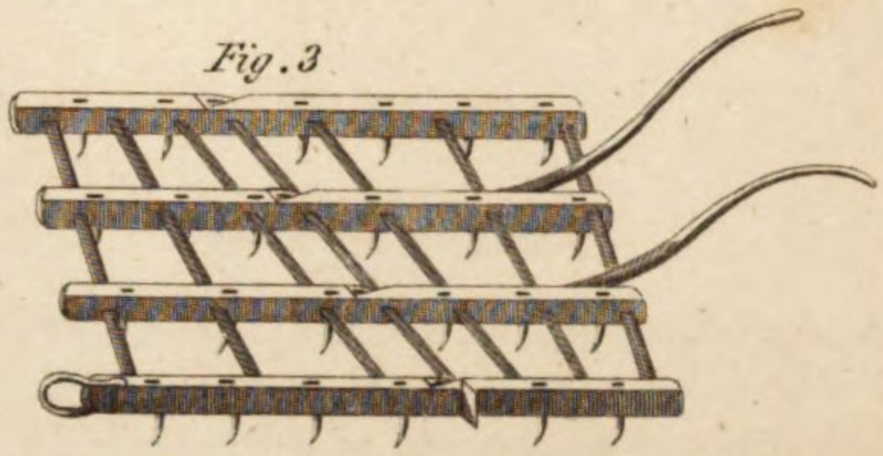


Fig. 3



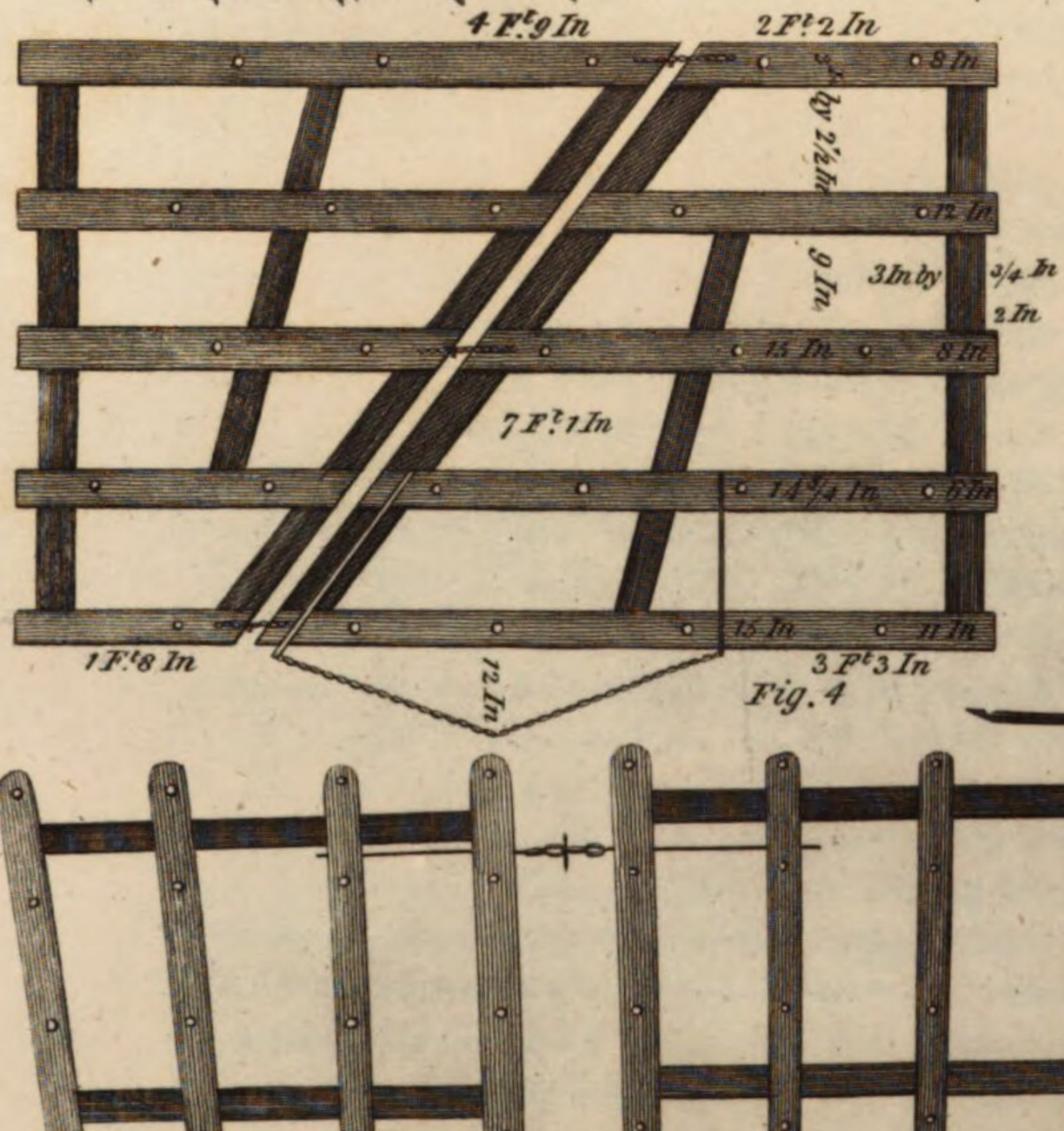


Fig. 4

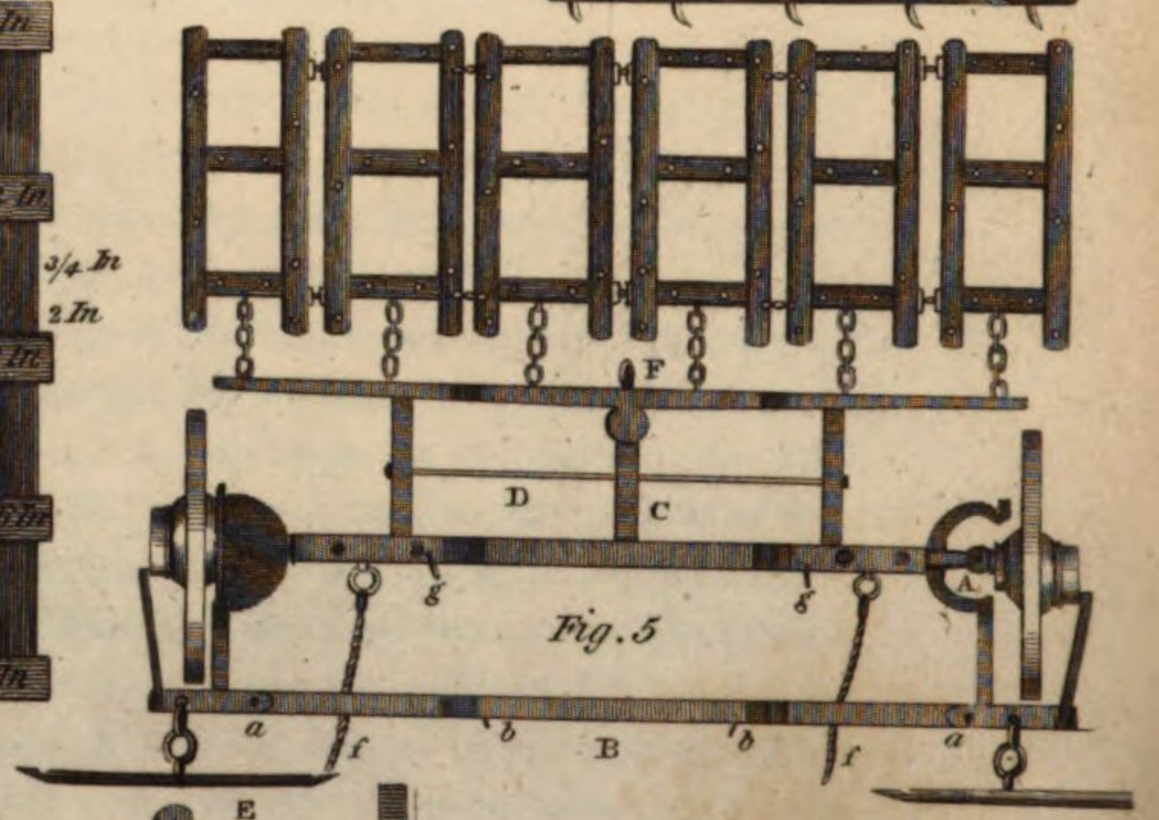
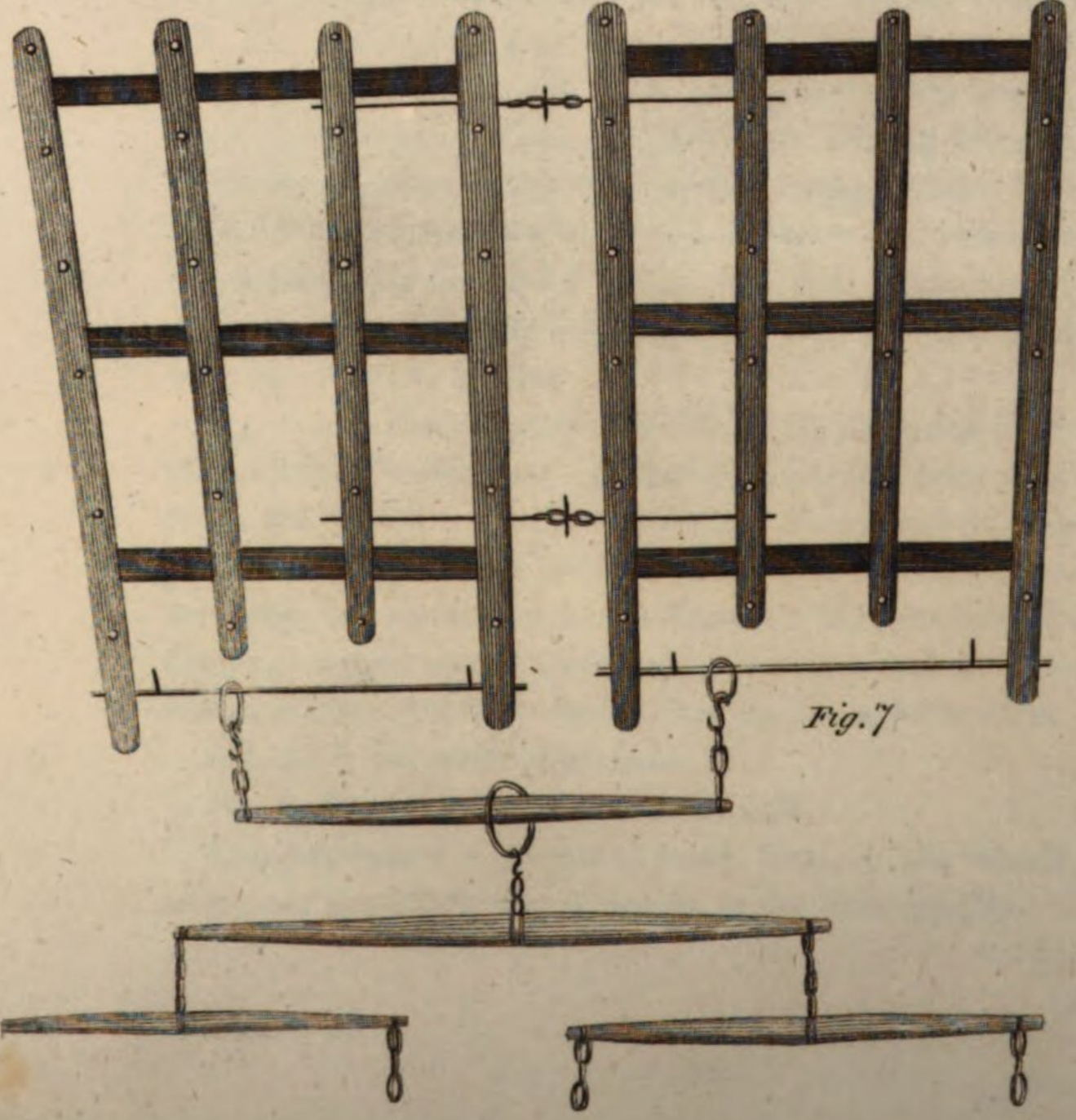
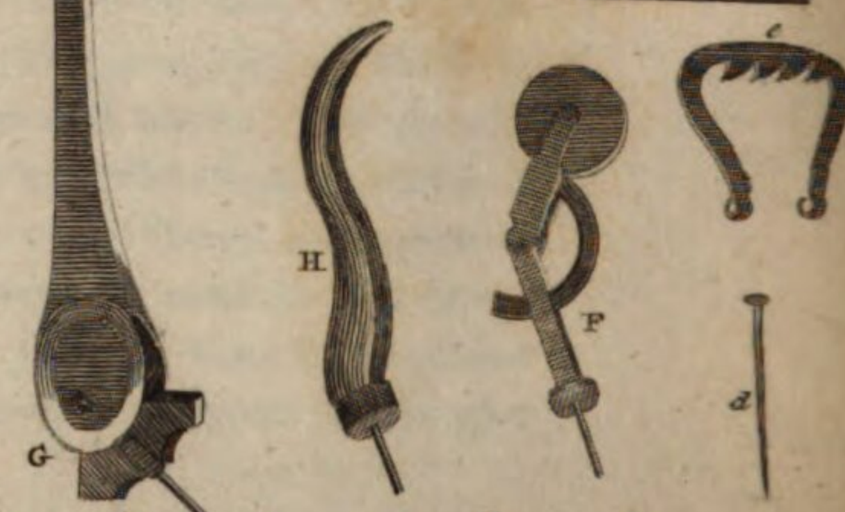


Fig. 5





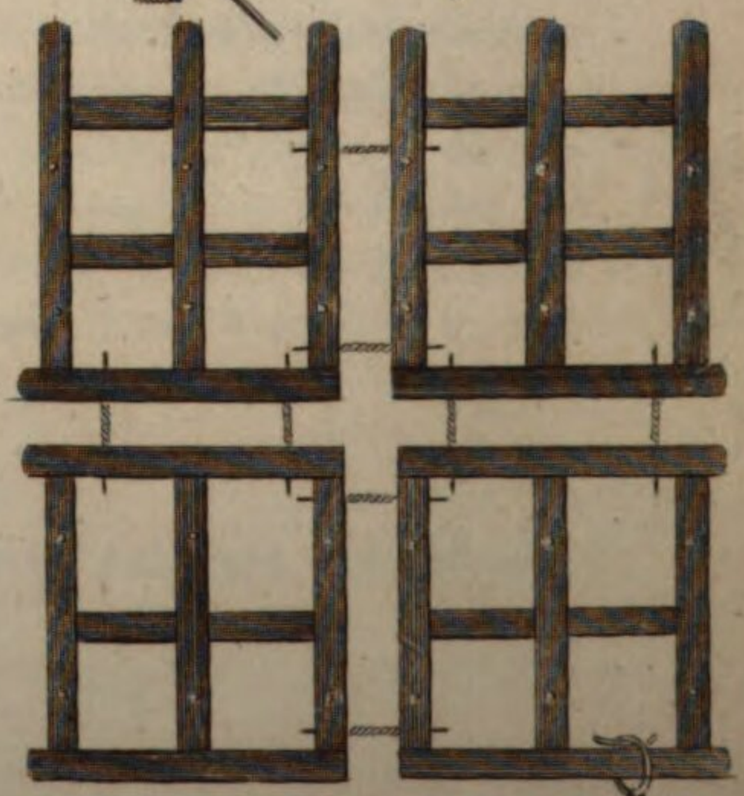


Fig. 6

Fig. 7

PLATE XI.

Common Harrows.

[*To face Page* 40.]

IMPROVED Common Harrows are much employed in many diſtricts.

Fig. 1. Is a *Common Harrow*, frequently made uſe of in firſt reducing the uneven ſurface left by the plough.

Fig. 2. A *Double Harrow* of the ſame kind.

Fig. 3. A *Jointed Brake Harrow*; to which are handles fixed behind for the purpoſe of raiſing it occaſionally, when it may be neceſſary to clear it from roots, &c.

Fig. 4. Is an *Improved Harrow* made uſe of by Mr. Grayburn in Lincolnſhire. From its being connected by hinges in the middle, it may be employed with great advantage where the ridges are much raiſed. It is recommended in the Agricultural Survey of that diſtrict.

Fig. 5. A *Wheel-Harrow* invented by Mr. Knight, by which the ſtreſs on the horſes is rendered leſs, and the harrow not ſo liable to choke up. It is conſtructed with two joints, A A, in the axle-tree, one of which is covered, as when the harrows are at work; the other uncovered, to ſhow the conſtruction of the joint; and two joints, *a a*, in the front of the bar, by means of which the pliability of the tree, and that of the bar, humour the wheels, and keeps them in their proper directions in the furrow; and, requiring very little ſcope of ground, the turnings are rendered convenient and eaſy. If in working the land the breadth of the furrows is varied, it is contrived, in order to make the harrow narrower, that that part of the bar B, which is faſtened by two pins *b b*, may be taken off when requiſite; part of the axle-tree, and part of the hind-bar C, both which are faſtened by the iron bolt D, are alſo to be removed; and the remaining outward parts to be joined and faſtened by one of the two pins in the bar, and by a ſhorter bolt *d*, ſhown ſeparate, and intended for the axle-tree and hind-bar. And when two horſes which are unequal in height are wrought, as the horizontal direction, or evenneſs of the joints, may be deſtroyed in ſome degree; to remedy and ſupply the deficiency in the horſes, the whipple-tree E is made to be heightened or lowered by means of notches *e*, ſhown ſeparate, to which it is connected by a ring. In light barley-lands, to accommodate the harrow for one horſe, by narrowing it as directed above, there are two ſtrings conveyed by two rings from the axle-tree, through two loops, *f f*, under the front bar. The wheel F, under the hind-bar, which is ſhown enlarged and ſeparate in the plate, will ſupport the bar; and by this aſſiſtance the harrow is conveyed to the field on the axle-tree bar, as a ſubſtitute for a ſledge: there are alſo two wooden pegs, *g g*, by which the harrows, when turned upon the carriage, are ſecured. To leſſen the expenſe of iron in this harrow, an axle-tree and joints may be readily conſtructed in wood, upon the ſame principle as ſhown in the plate ſeparate at G; though preference ſhould be given to iron. If the wheel under the hind-bars be not adopted, there is a ſlider H, ſhown ſeparate, which works with a pin, and, when not wanted, is turned and faſtened under the axle-tree. As it is often found uſeful to heighten or lower the harrow occaſionally, particularly on broad lands riſing in the middle; where of courſe the middle harrow takes moſt hold, and generally requires the leaſt; this may be eaſily effected, by fixing irons, with notches, like thoſe on the fore-bar, by which the whipple-trees are ſupported, on the hind-bar, inſtead of the hooks, and putting the hooks on thoſe irons.

At *Fig.* 6. A *Four-ſquare Harrow*, employed on new-incloſed and broken-up lands in the midland diſtricts, where the ground is very uneven.

Fig. 7. An *Improved Harrow*, with *running bulls*: By this contrivance the harrows are prevented from riding on each other, or turning over at the ends of the ridges in returning. They are made by Mr. Hanford, and found to anſwer well in Leiceſterſhire. The price about 3l. 3s.

PLATE XI.

Common Harrows.

[To face Page 40.]

Improved Iron Harrows.

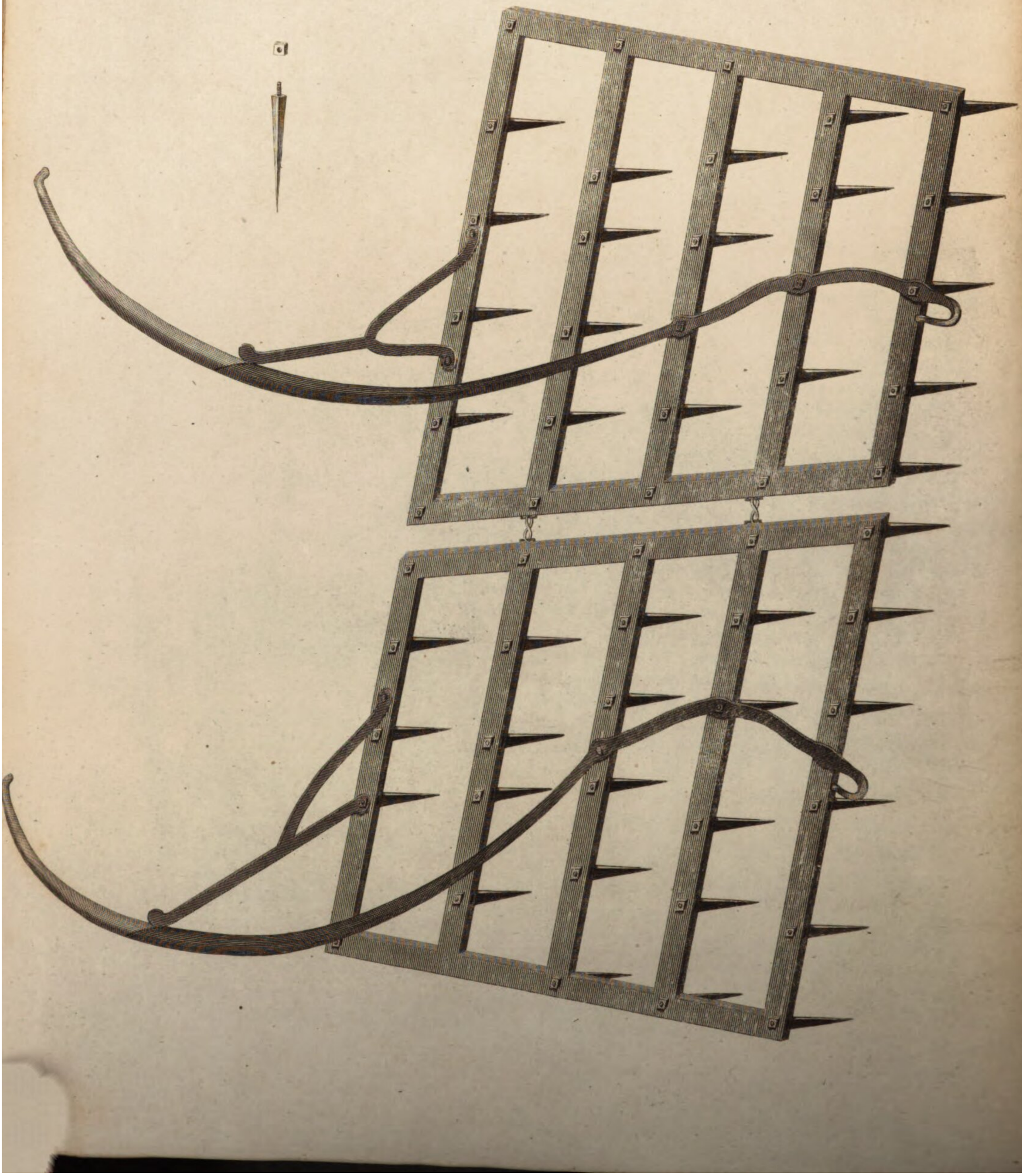


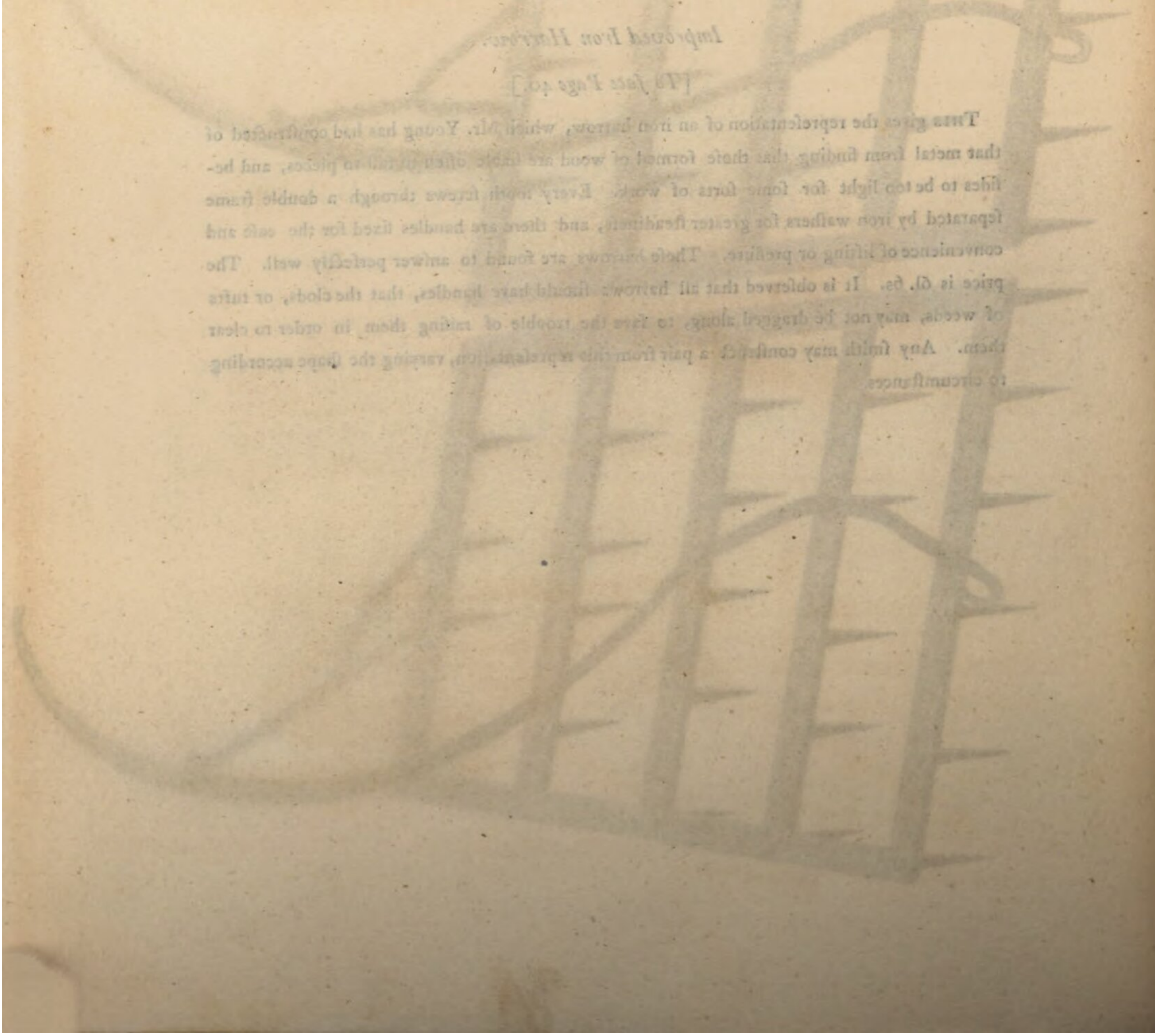
PLATE XII.

Improved Iron Harrow.

[*To face Page* 40.]

THIS gives the repreſentation of an iron harrow, which Mr. Young has had conſtructed of that metal from finding that thoſe formed of wood are liable often to fall to pieces, and beſides to be too light for ſome ſorts of work. Every tooth ſcrews through a double frame ſeparated by iron waſhers for greater ſteadineſs, and there are handles fixed for the eaſe and convenience of lifting or preſſure. Theſe harrows are found to anſwer perfectly well. The price is 6l. 6s. It is obſerved that all harrows ſhould have handles, that the clods, or tufts of weeds, may not be dragged along, to ſave the trouble of raiſing them in order to clear them. Any ſmith may conſtruct a pair from this repreſentation, varying the ſhape according to circumſtances.

PLATE XII.



ROLLERS.

Fig. 1.

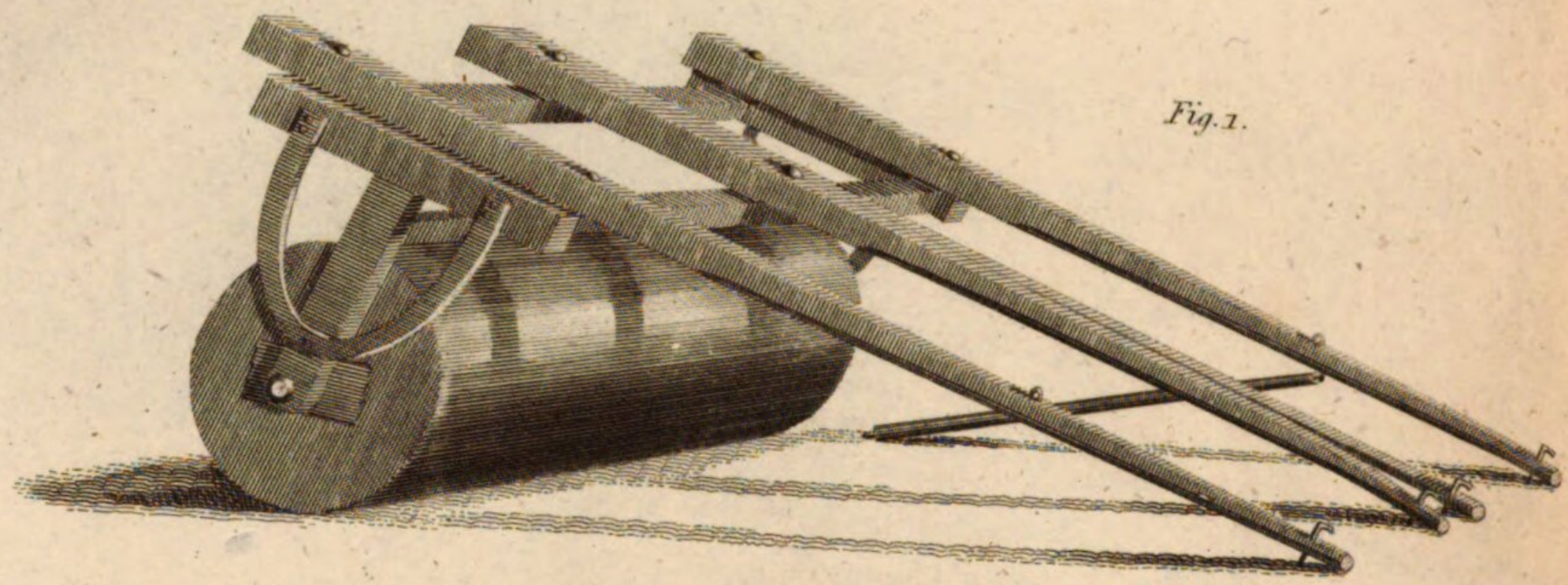


Fig. 2.

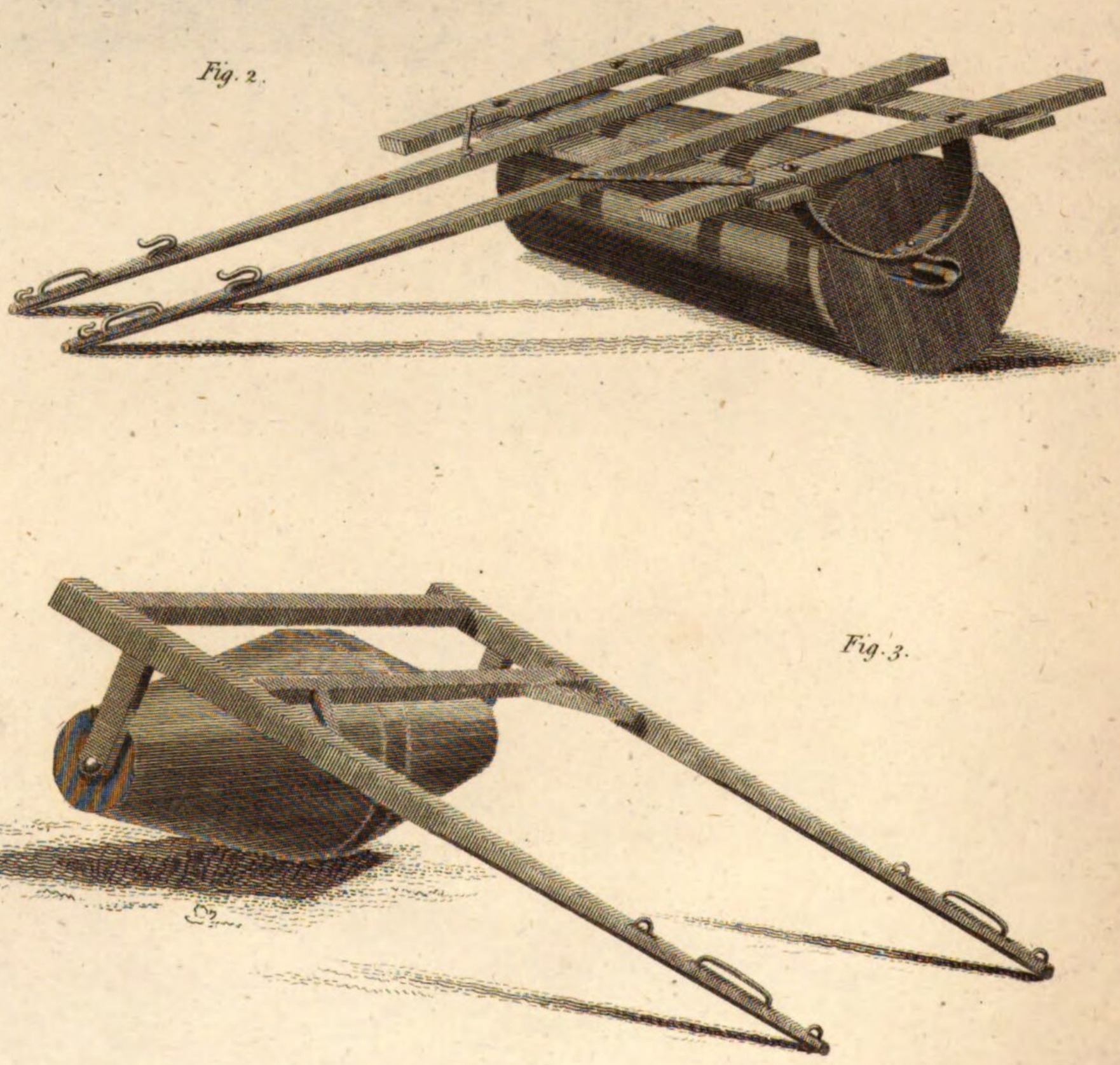


Fig. 3.

PLATE XIII.

Rollers.

[*To face Page* 40.]

Fig. 1. Is the repreſentation of a *common graſs-roller*, employed for rolling hay lands in the county of Middleſex.

It is drawn by three or four horſes abreaſt.

Fig. 2. Is a common *ſtone roller*, made uſe of in many of the northern diſtricts for rolling arable lands.

Fig. 3. Exhibits the plan of a *furrow roller* invented by Mr. Pinchard, for rolling the furrows in hilly and other lands, where the common rollers cannot be employed.

THRESHING MACHINES.

Fig. 1.

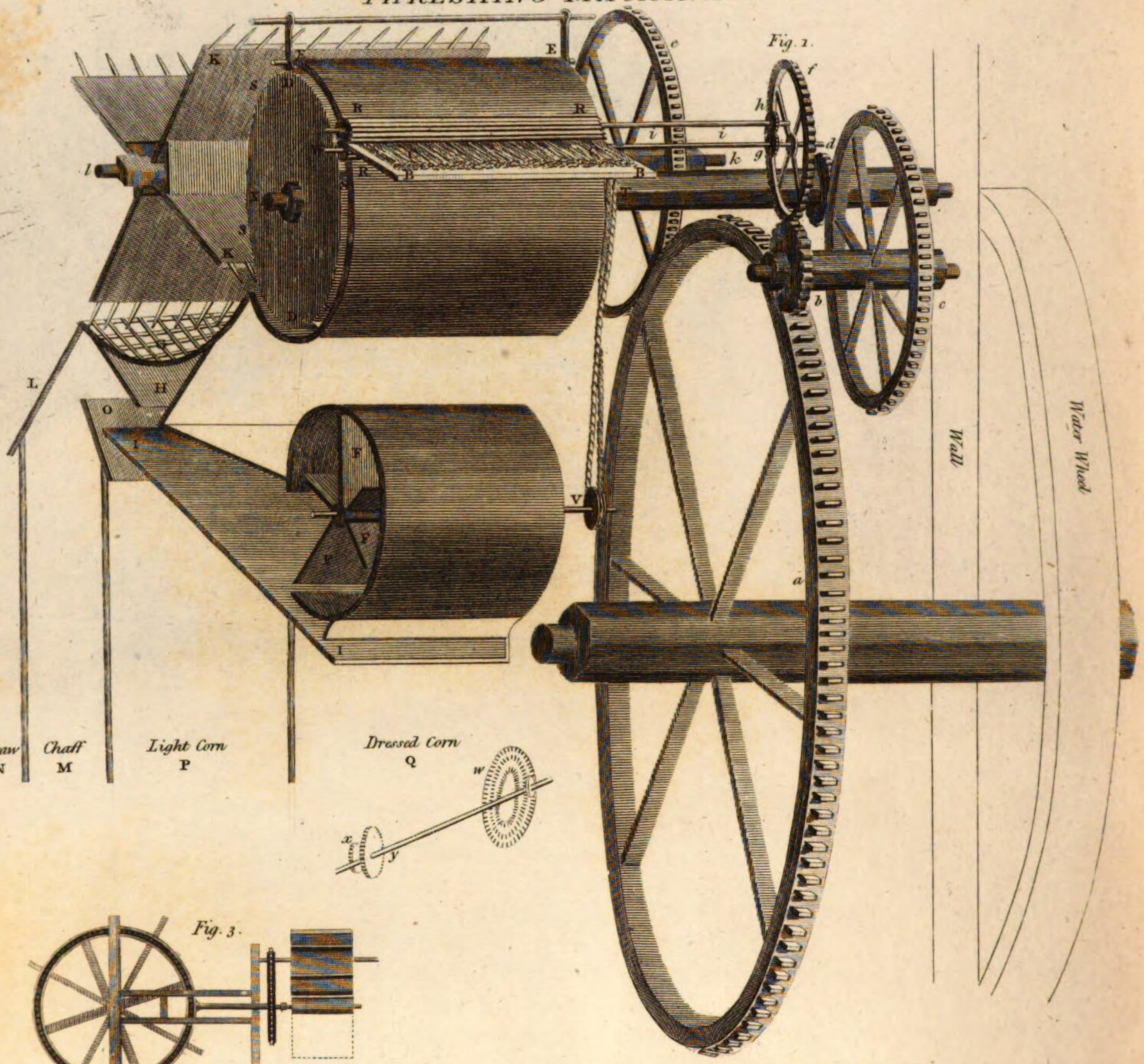


Fig. 3.

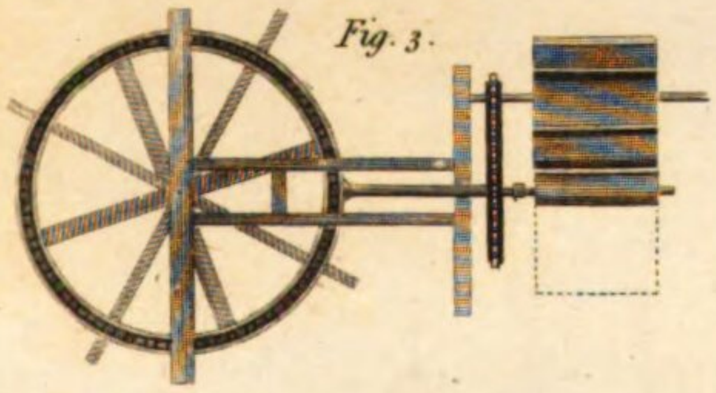


Fig. 2.

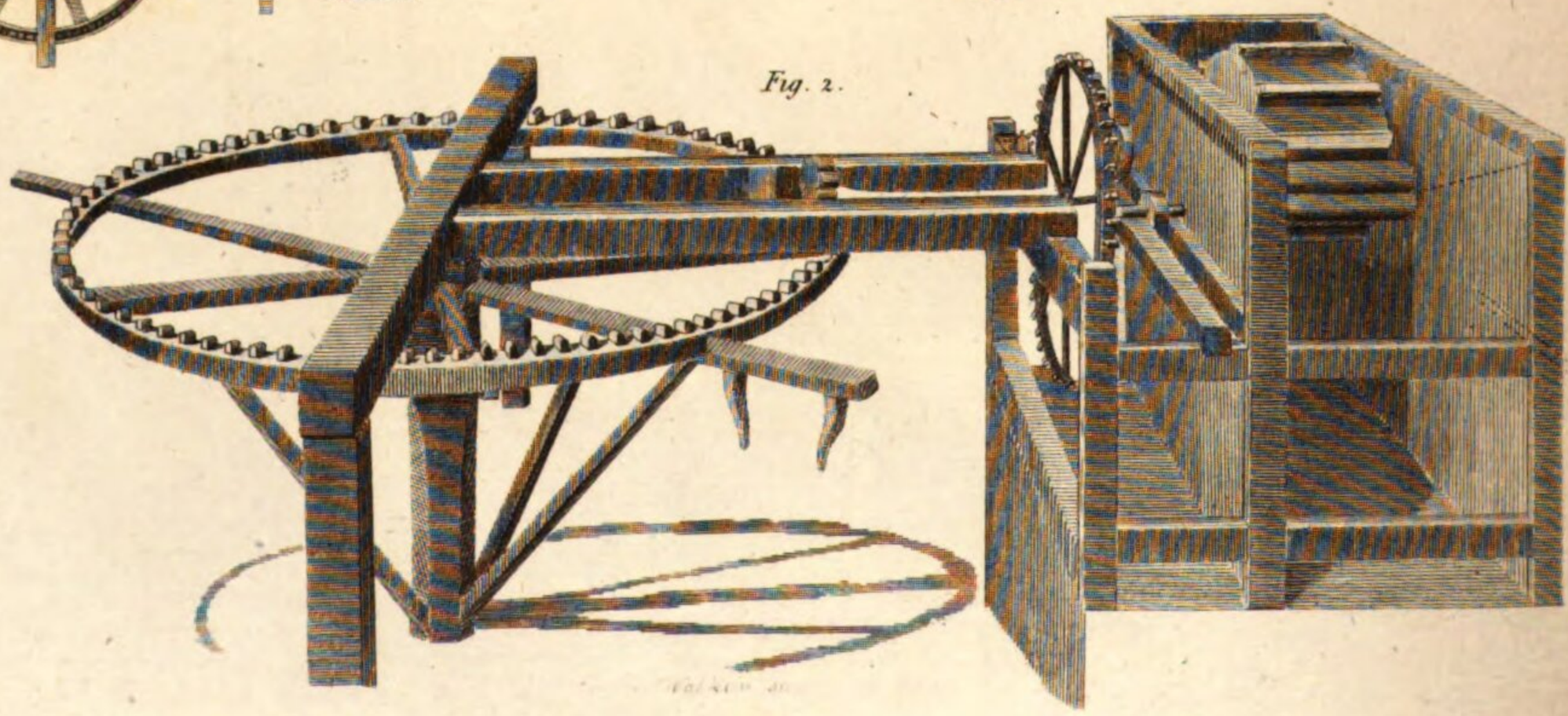


PLATE XIV.

Thraſhing Machines.

[*To face Page* 40.]

Fig. 1. is the repreſentation of a powerful thraſhing machine, in which B B is a horizontal board or table five feet long by three feet four inches broad, on which the corn CC is *evenly ſpread*, and preſented to the caſt-metal fluted rollers RR (four inches in diameter), which take it regularly in, and by their weight and ſharp edges hold faſt the ſtraw while it is ſtruck or thraſhed out by the pieces of wood SSSS, fixed in the cylinder DD, and projecting three inches from its ſurface. This cylinder is made with ſtrong arms, on which are fixed the pieces of wood, and caſed round with narrow inch deals; the whole ſecured from flying off by ſtrong iron hoops ſurrounding them at each end; the former are covered with plate iron, to prevent their wearing. Theſe, when they ſtrike the corn, move in an upward direction RE, with great velocity, and throw the corn as it is thraſhed, and the ſtraw as it leaves the fluted rollers, againſt the circular rake KK, and upon the wire ſkreen G, from whence the ſtraw is taken by the rake, and delivered upon the ſloping board L, down which it ſlides to the floor N, while the corn paſſes through the ſkreen G into the hopper H, and from thence to the inclined board I; but in falling from H to I a ſtrong current of air, raiſed by the fanners FFF, blows the chaff over the ſloping board O, and the light corn againſt it, which falls into the ſpace P, and the chaff into M, while the good grain ſlides down the inclined board II, to the floor at Q, from whence it is taken and put into a ſecond winnowing machine, in which are placed proper riddles to ſuit different kinds of grain. This ſecond machine is moved by a rope going over a pulley, fixed in the axle T, and is ſet a-going, or ſtopped, at pleaſure, by a ſtretching pulley, as occaſion may require.

But where the ſituation will admit of the board II being placed about four feet from the floor, the ſecond winnowing-machine may be placed directly under it, and ſave the trouble of lifting the corn. The whole is put in motion by an overſhot water-wheel fourteen feet diameter, which makes from five to ſix revolutions per minute, according to the ſupply of water; on the axle of this water-wheel is fixed a large ſpur-wheel *aa*, of 160 cogs (152$\frac{3}{4}$ inches diameter), which drives a caſt-metal pinion *b*, of 16 cogs (15,28 inches diameter), on the axis of which is placed another ſpur-wheel *c*, of 63 cogs (60,1 inches diameter), that drives the caſt-metal pinion *d*, of 16 leaves, (15,28 inches diameter) on the axis of which is fixed the cylinder DD, (four feet diameter, and five feet long) with the four projecting pieces of wood, SSSS, that thraſh the corn as deſcribed above. The large ſpur wheel *a* alſo drives the light cog wheel *e*, of 63 cogs (60,1 inches diameter), fixed on the axis *k l* of the rake for taking away the ſtraw.

The rollers are moved by the pinion *b*, of 16 leaves, working into the ſlight caſt-metal wheel *f*, fixed on the iron axis *ii* of the lower roller, on which axis is alſo fixed a ſmall pinion *g*, of 8 leaves, working into another, *h*, of equal number, fixed on the axis of the upper roller, which gives the two rollers an equable motion for taking in the corn. This axis is fixed into the upper roller, either by an univerſal joint, or with a ſquare tapering end, to allow the upper roller to riſe and fall, according as the corn is fed-in thicker or thinner; and the concave board RE is hung on a bolt, to allow it to riſe and fall with the roller.

When the rollers are required to move ſwifter or ſlower, they may be driven very conveniently from the end of the axle of the rake, by fixing a caſt-metal *faced wheel* on it, with three rows of cogs, (8, 10, and 13) working into a ſhifting pinion of 8 leaves, fixed on an iron axle; at the other end of which is put a ſmall *bevel* wheel of twelve teeth, working into another of eight teeth on the end of the axle of the lower roller. The fanners are moved by a croſſed rope, paſſing over a pulley T, 10 inches diameter, fixed on the axis of the cylinder, and another V, of 8 inches diameter, on the axis of the fanners. The rollers take in nearly 300 inches of corn per minute with a medium quantity of water.

w x and *y* explain ſeparately the manner in which the ſmall wheels are attached.

This machine was found to anſwer well at Chillingham by Mr. Baily.

Fig. 2. Exhibits another thraſhing machine conſtructed on a different principle.

Fig. 3. Repreſents the plan of it.

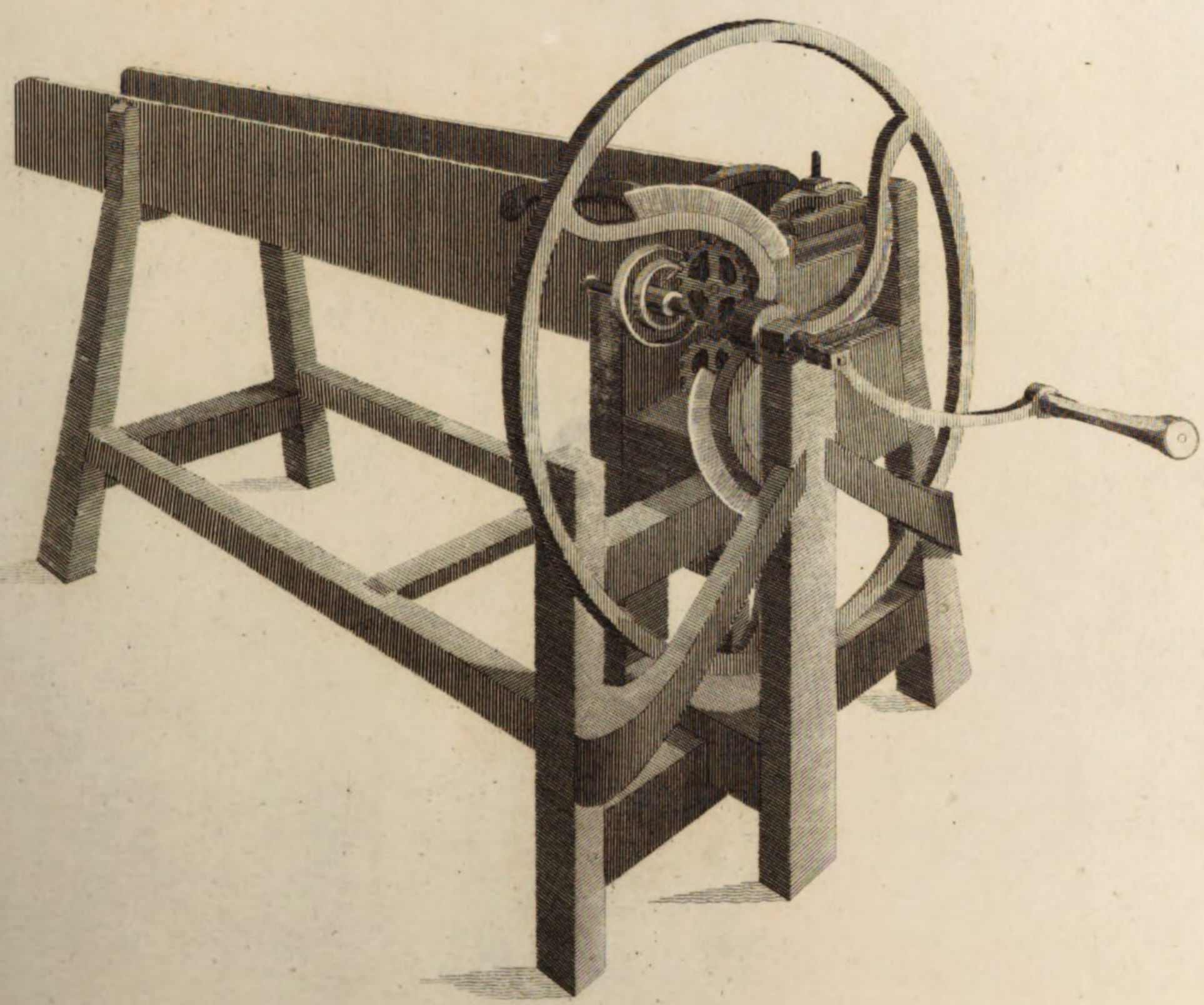


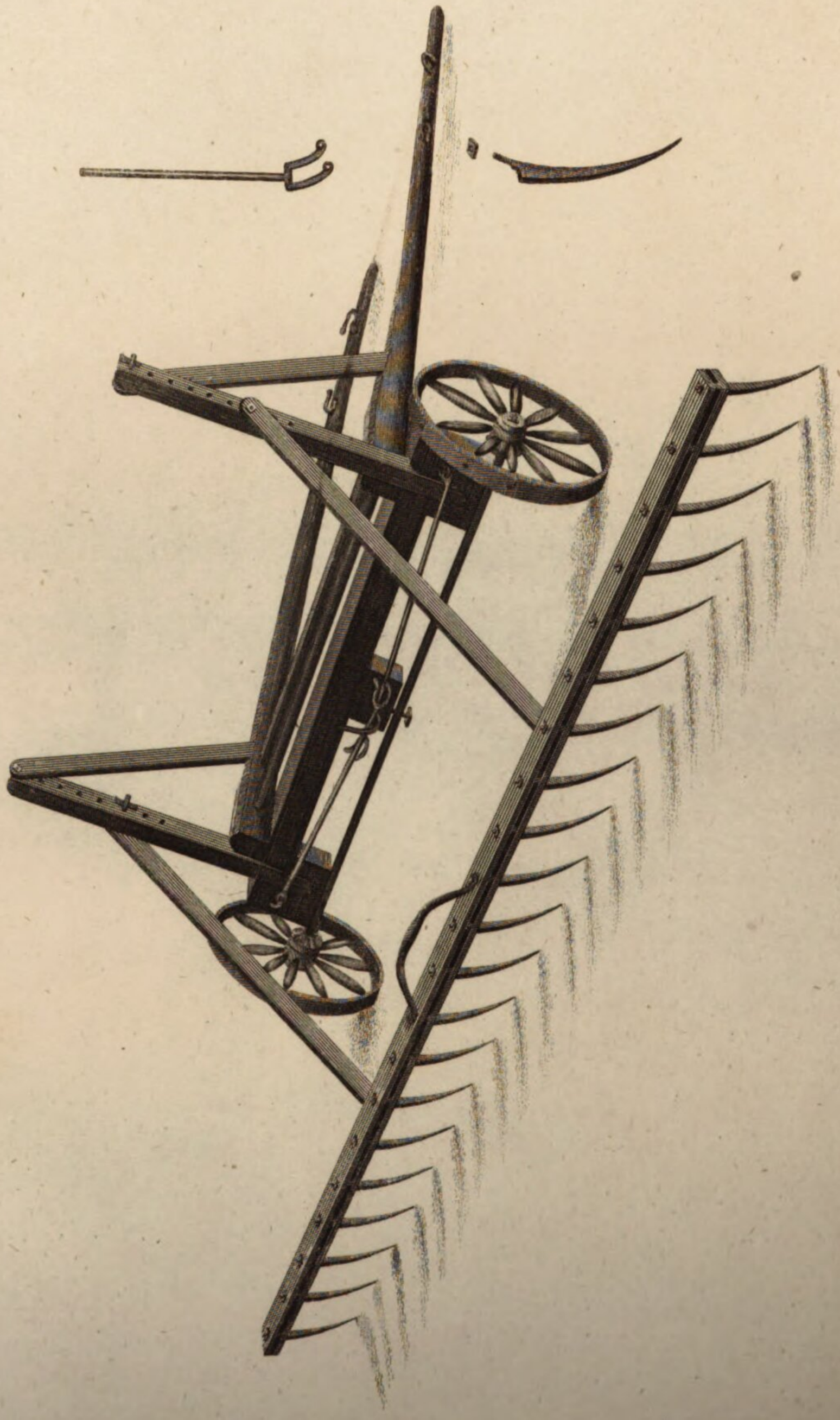
PLATE XV.

Chaff-Cutter.

[*To face Page* 40.]

THIS figure repreſents Mr. Mc Dougall's Patent Chaff-cutter, which muſt be conſidered as one of the moſt uſeful inſtruments of the kind ever invented. In this machine the inventor has been particularly careful ſo to conſtruct it, that, in caſe it ſhould be accidentally broken, it might be eaſily repaired by any common mechanic. The ſubſtance to be cut into chaff may be preſſed as hard as the workman chooſes, by ſimply placing a weight nearer to the end of the lever. But the chief excellence of the inſtrument conſiſts in Mr. Mc Dougall's having judiciouſly applied a ſpiral groove in the room of the endleſs ſcrew, commonly uſed by other agricultural inſtrument-makers; by means of which he has in a great degree got rid of friction; and the lever may riſe to any height, without putting the machine out of work.

NORFOLK & SUFFOLK HORSE RAKE.



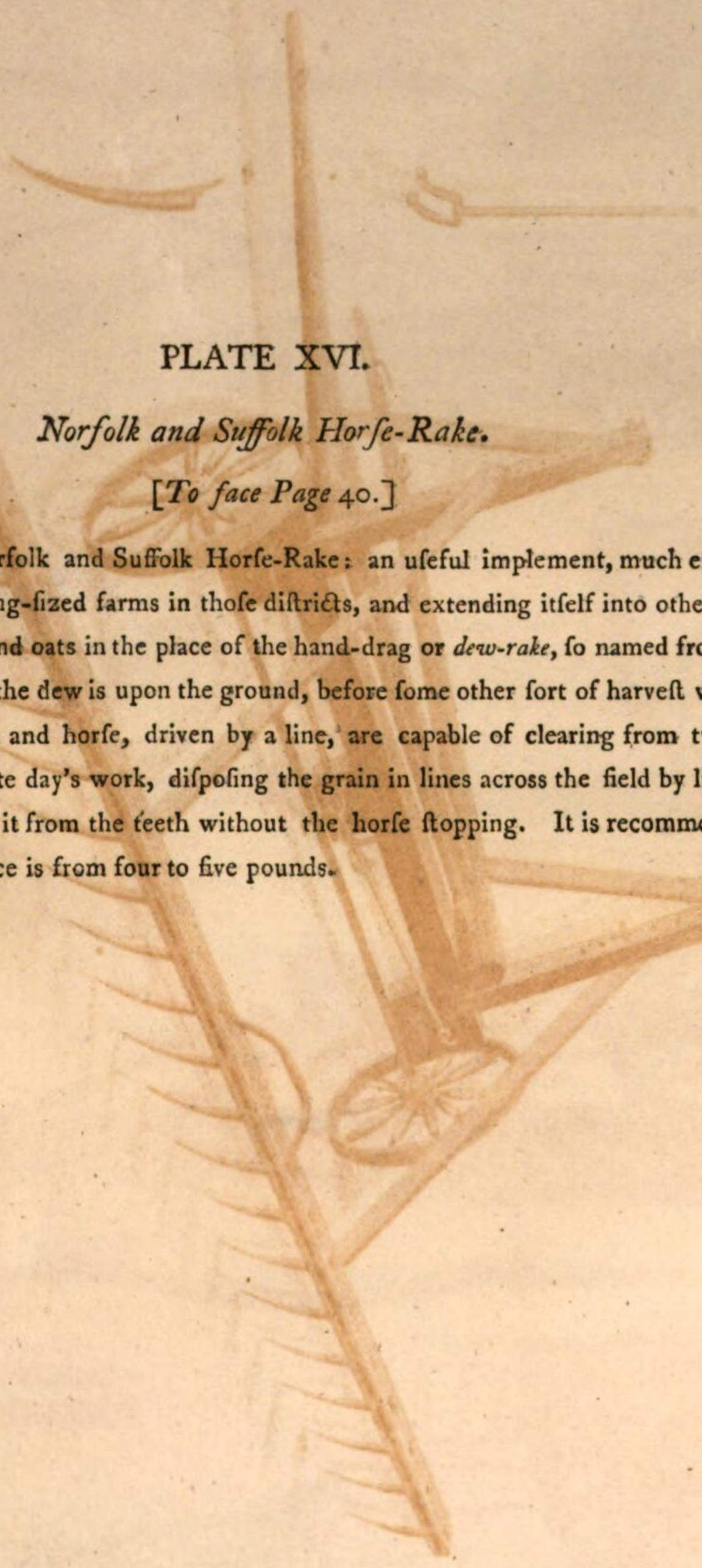
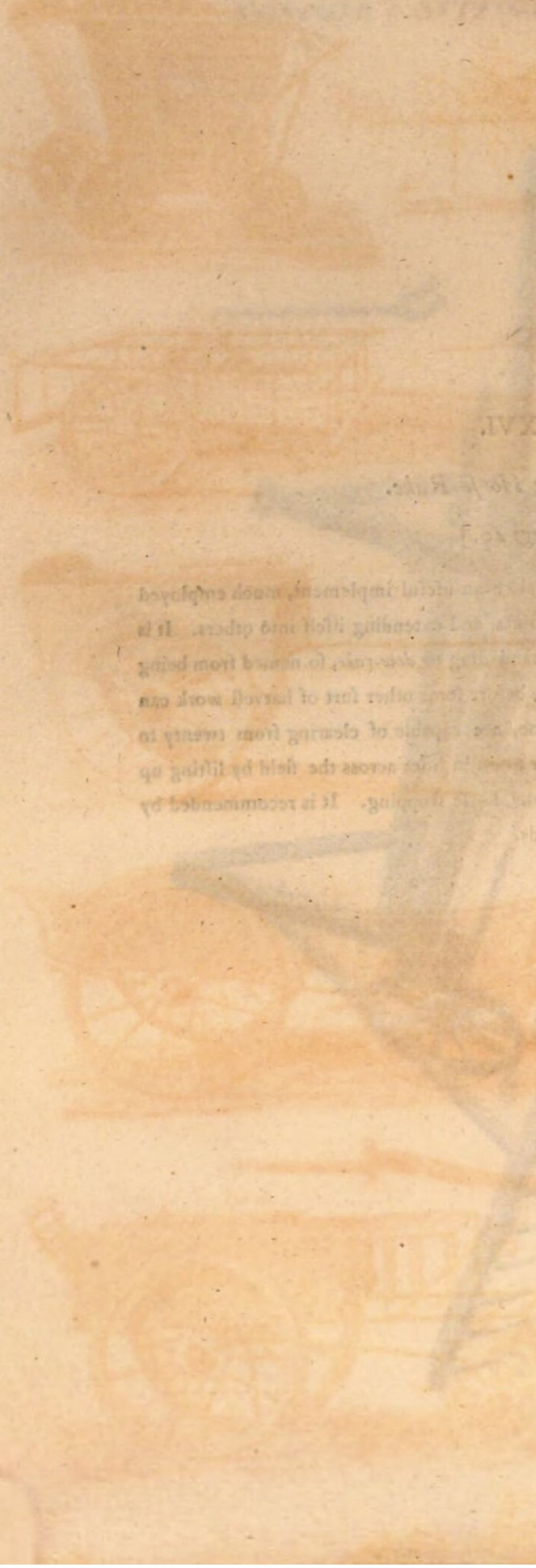


PLATE XVI.

Norfolk and Suffolk Horſe-Rake.

[*To face Page* 40.]

REPRESENTS the Norfolk and Suffolk Horſe-Rake: an uſeful implement, much employed on the large and middling-ſized farms in thoſe diſtricts, and extending itſelf into others. It is made uſe of for barley and oats in the place of the hand-drag or *dew-rake*, ſo named from being chiefly employed while the dew is upon the ground, before ſome other ſort of harveſt work can be undertaken. A man and horſe, driven by a line, are capable of clearing from twenty to thirty acres in a moderate day's work, diſpoſing the grain in lines across the field by lifting up the rake, and dropping it from the teeth without the horſe ſtopping. It is recommended by Mr. Young. The price is from four to five pounds.



CARTS and WAGGONS.

Fig. 10.

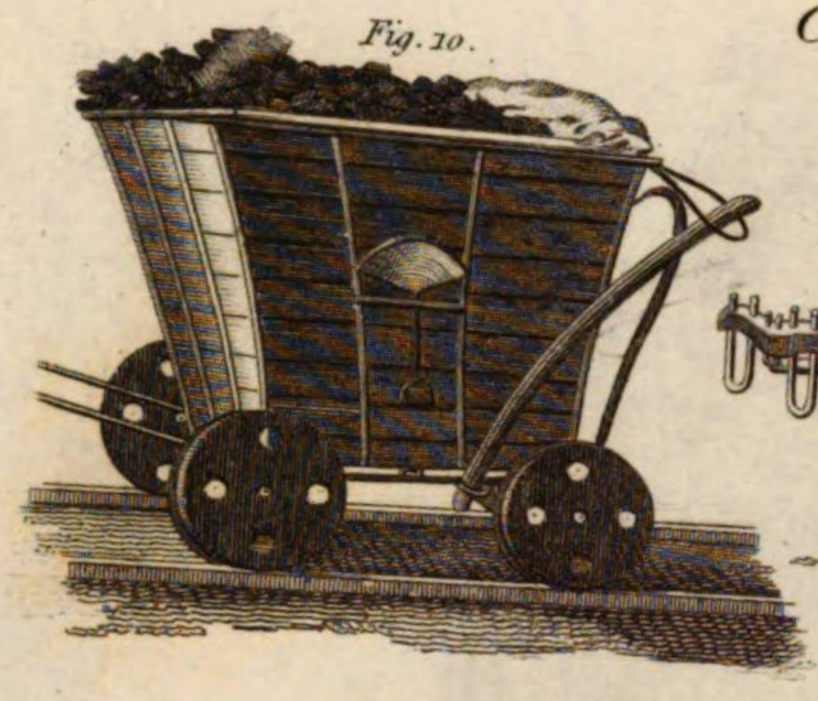


Fig. 5.

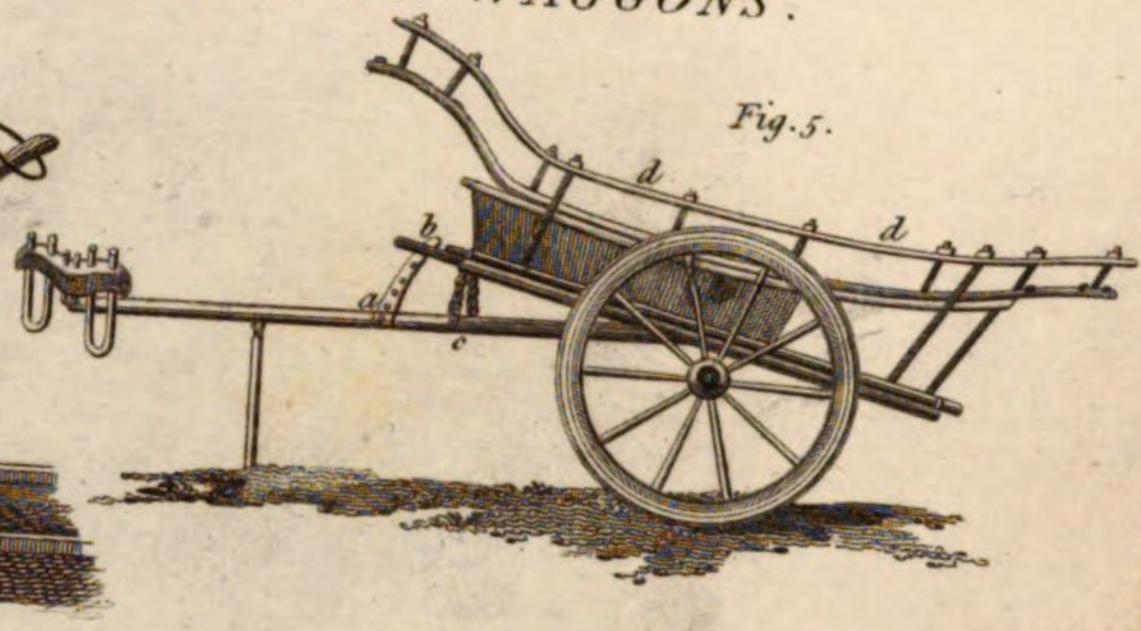


Fig. 2.

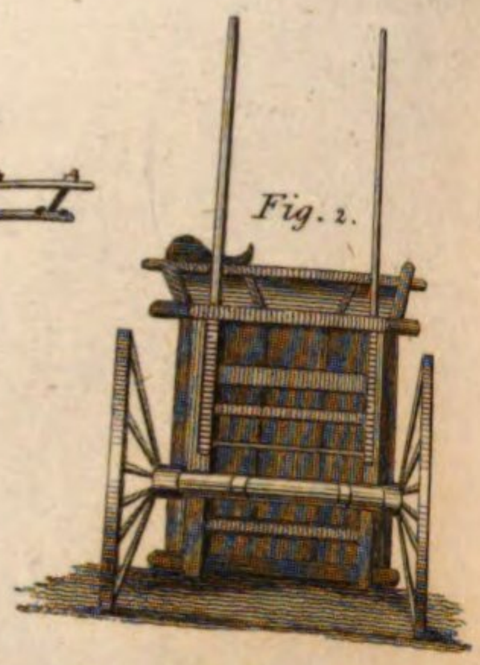


Fig. 3.

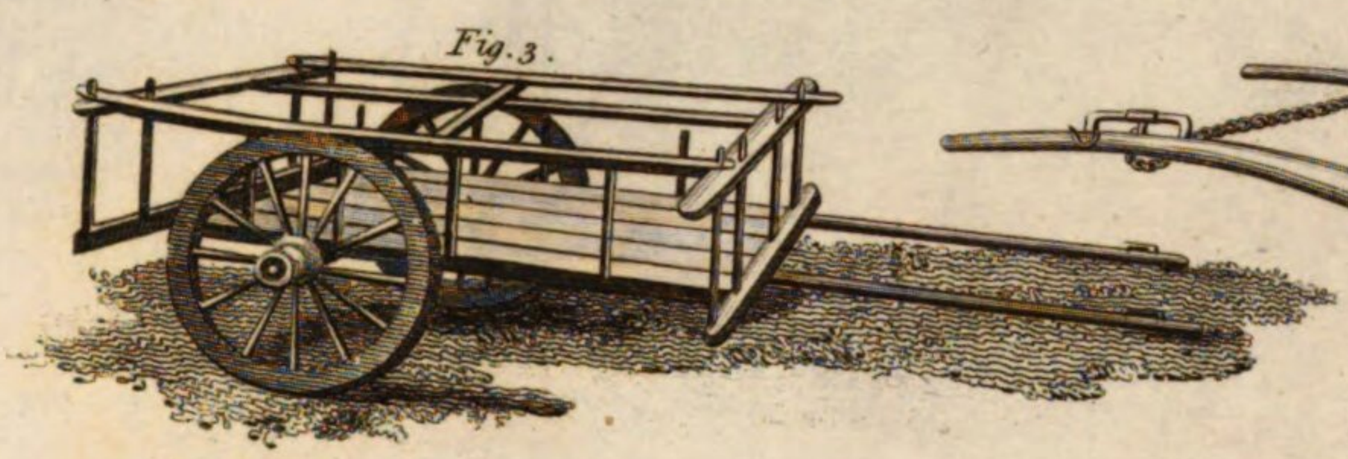


Fig. 7.

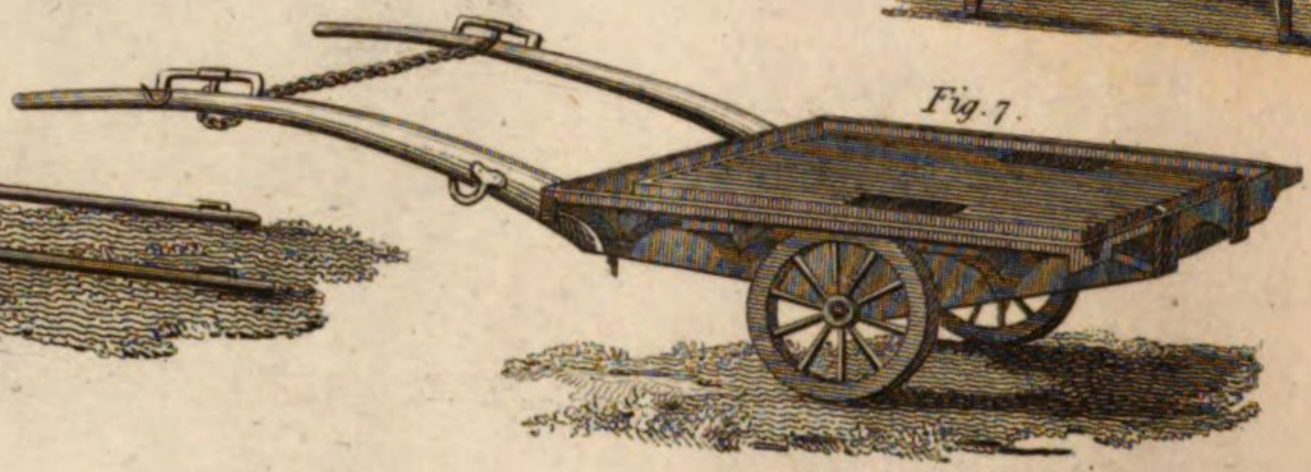


Fig. 1.

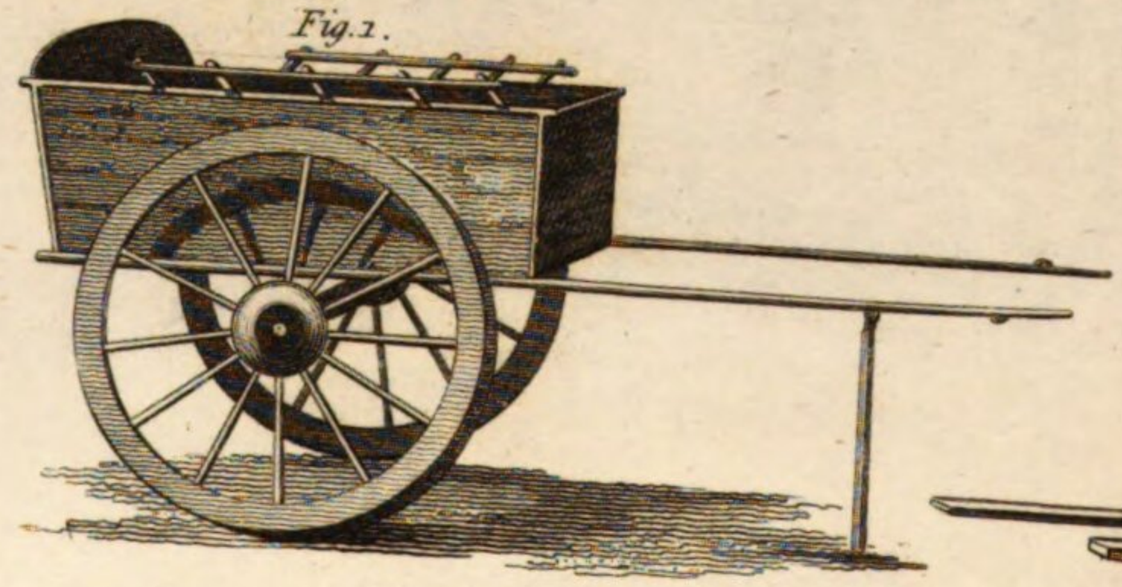


Fig. 4.

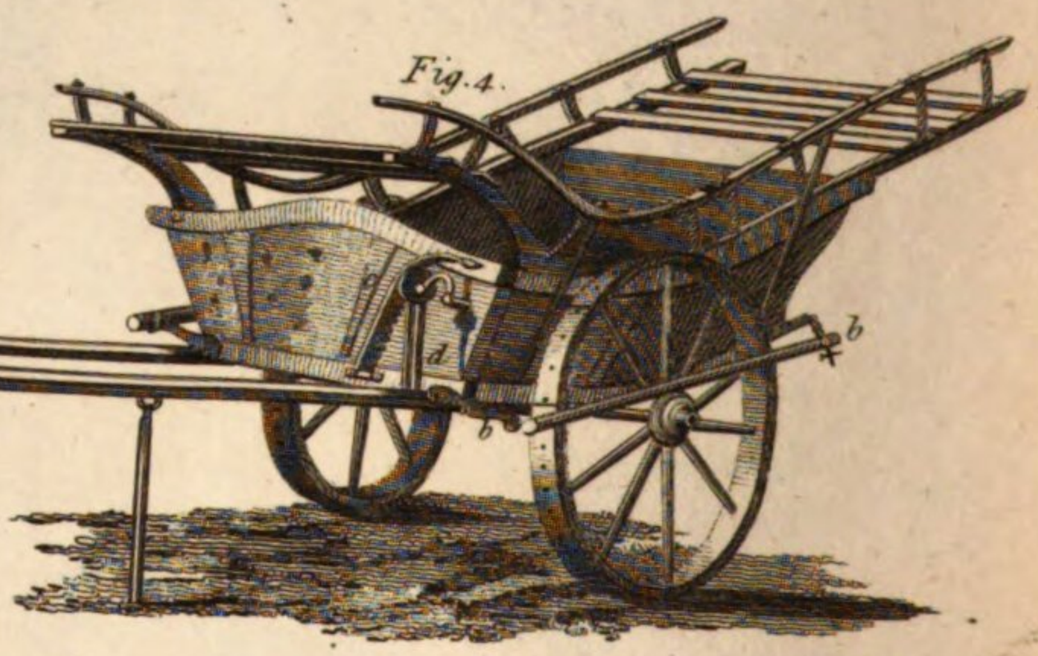


Fig. 11.

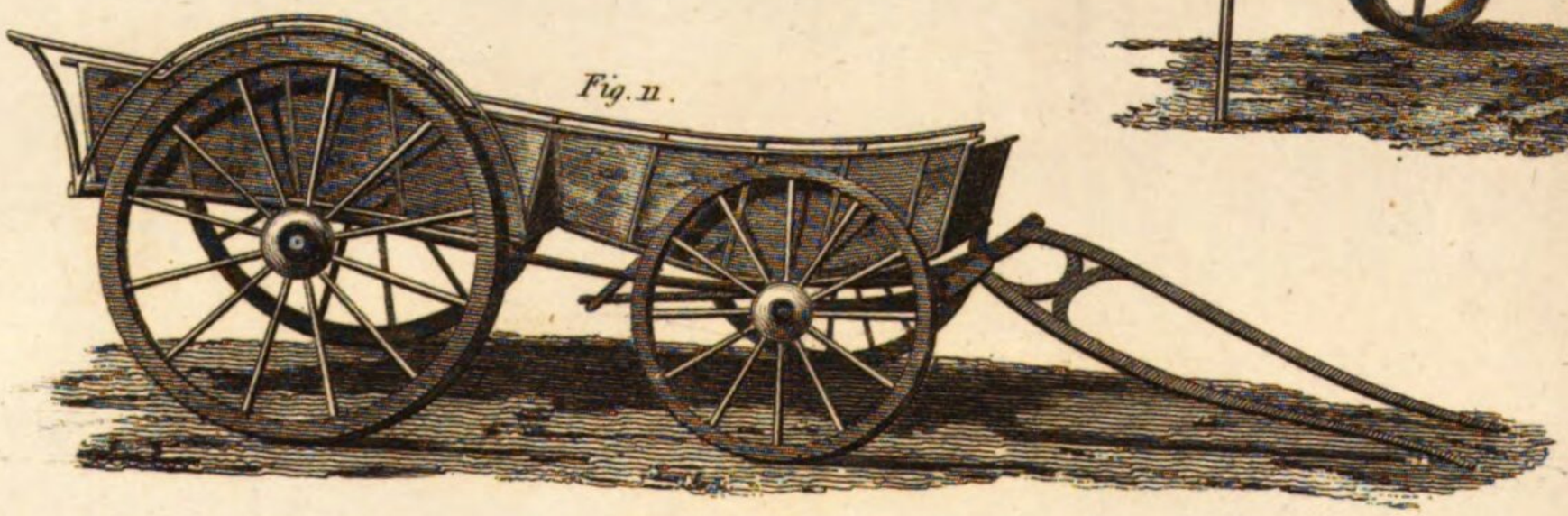


Fig. 8.

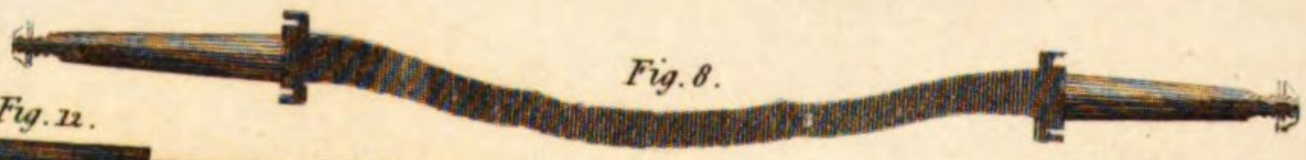


Fig. 9.

Fig. 12.

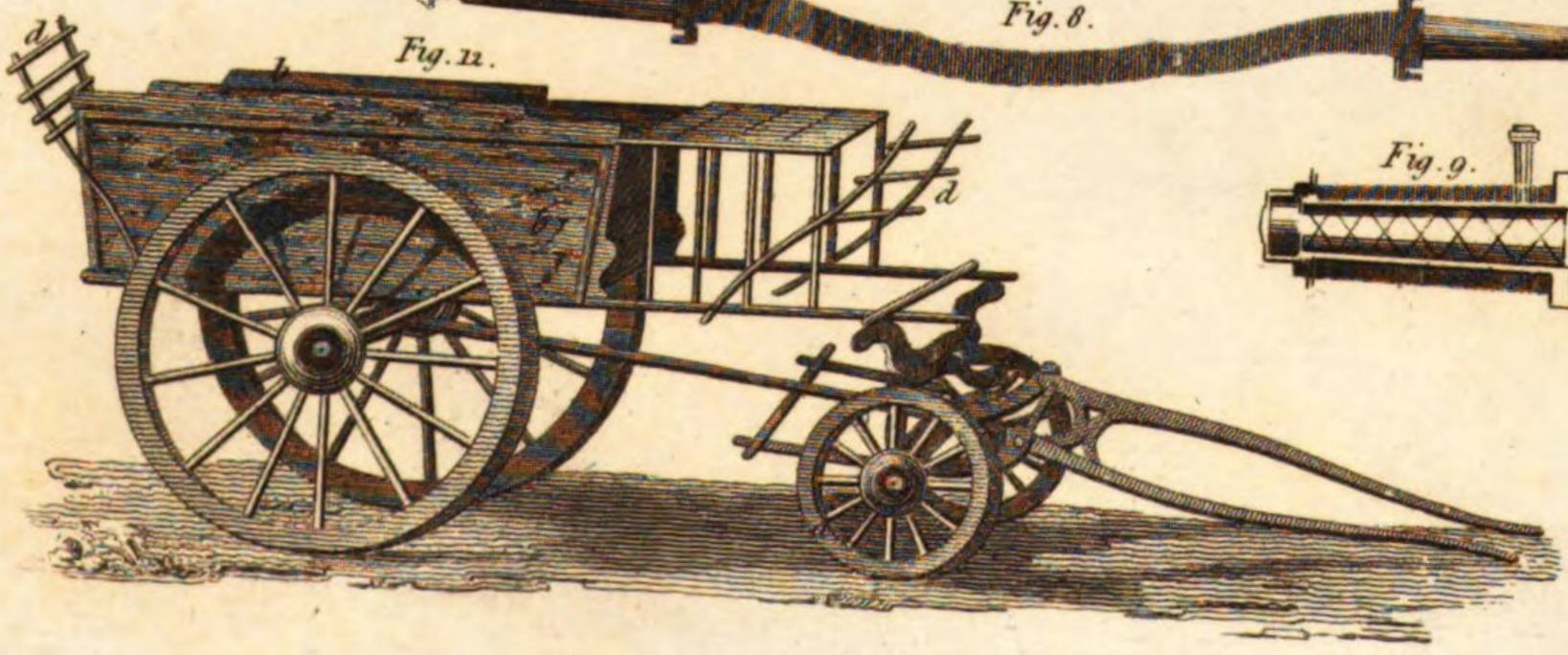
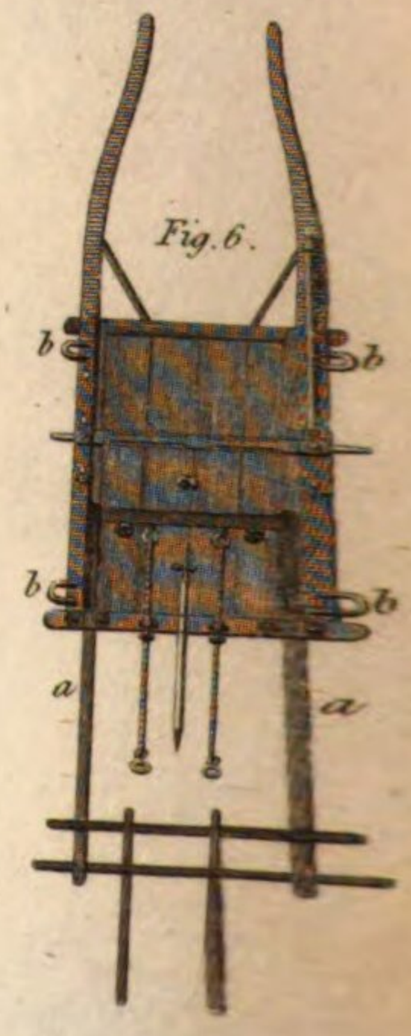


Fig. 6.



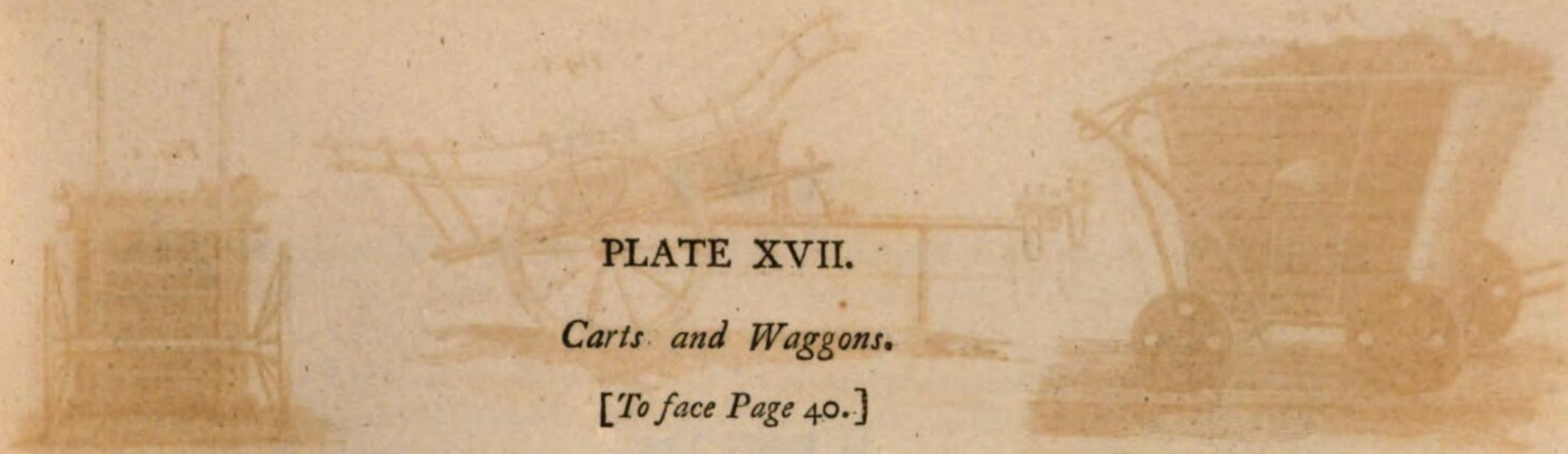


PLATE XVII.

Carts and Waggons.

[*To face Page* 40.]

AT *Fig.* 1. is repreſented a common light one-horſe cart for various uſes.

Fig. 2. A cloſe ſingle-horſe cart, uſeful for conveying manure or other ſimilar purpoſes: it is ſometimes termed a *coup-cart*; the body reſting upon a ſort of frame, by which contrivance the contents can be readily diſcharged.

Fig. 3. Is a cart made uſe of in ſome northern diſtricts for conveying hay and grain in the ſtraw, or any other bulky materials, where only one horſe is employed.

Fig. 4. Is a front view of a *Drag-Cart* recommended by Lord Somerville; it is drawn by a ſingle horſe in ſhafts. The too great velocity of the cart, in deſcending ſteep hills, is counteracted by a friction-drag or bar, *b b*, fixed behind by a chain and before by a toothed rack, *b d*, which catches on a ſtaple, by which the preſſure is regulated by the driver. The poſition, or centre of gravity of the load, is alſo regulated by a toothed rack fixed in the front of the cart at *c*.

Fig. 5. Is a ſide view of a cart of this ſort, deſigned for oxen, the friction-drag being removed. In this a more ſimple method of adjuſting the centre of gravity of the load is adopted, as ſeen at *a b*, by the curved iron with holes in it for receiving a pin to hold it at any height required. *c*. A ſmall chain to hold the cart from going too far back in fixing it; *d d*, upper part of cart for containing bulky loads.

Fig. 6. Repreſents the body of a cart which can be enlarged occaſionally for bulky loads by means of the ſlides *a a*. The ſides alſo put on and take off at pleaſure, as ſhown by *b b*, &c.

Fig. 7. Exhibits a view of the *Quarry-Cart*, a ſtrong low cart for the loading and carrying of heavy ſtones, and great weights of other kinds.

Figs. 8 *and* 9. Repreſent an axletree and box conſtructed by Mr. Rowntree, which run light and retain their oil perfectly.

Fig. 10. Is the repreſentation of a waggon employed in the collieries for conveying coals.

Fig. 11. Is a repreſentation of a light waggon much uſed in Berkſhire: It is valuable, from its lightneſs, for harveſt and other ſimilar purpoſes.

Fig. 12. Is another waggon, which partakes, in ſome degree, of the properties of the cart and waggon, whence it has been appropriately denominated *Hermaphrodite*. The pair of fore-wheels and ſhafts, as *a a*, are occaſionally attached to a common cart, *b b*, by a pole connected with the axle, to which are added the ladders *d d*. This is a light, cheap, and convenient carriage, and will carry nearly as much hay or ſtraw as the above waggon.

SECTION II.

Farm-Houſes and Offices.

FARM BUILDINGS—Too little Attention in the Conſtruction of—Facility and Diſpatch of Buſineſs connected with Form and Arrangement of—Commodious Diſtribution of, neceſſary—When not the Caſe, much Time loſt in the Conveyance of Materials—Size of, proportioned to that of the Farm—When of the grazing Kind few Buildings neceſſary—Theſe chiefly of the cheap ſhed Kind—Permanent Roofs moſtly advantageous—Expence ſaved by Walls with occaſional Coverings—This Plan only recommended in particular Caſes—Different Sorts of Sheds neceſſary for different Kinds of Cattle—Cool ones for Store Cattle—Warm ones for Feeding Stock—Different Accommodations neceſſary for Dairy Farms—Cow-Houſes large—Conveniences for the various Operations of the Dairy—For Corn Farms Buildings more numerous—Calculated to ſuit different Purpoſes—Stables ſufficiently large—Cow and Feeding Houſes adapted to Number and Kind of Cattle—Barn and Granary ſufficiently large—Where Throſhing-Machines are erected need not be ſo extenſive—Conveniences for young Animals of different Sorts—Horſes—Cattle—Hogs—Poultry.—FARM HOUSES—Dimenſions of, regulated by Size of Farm—Should be airy and commodious—Ground-floor Plan—Parlour—Kitchen—Back Kitchen—Cloſets for various Articles—Dairy—Pantry—Cellar—Divided above into Lodging Rooms—Theſe large for the Sake of Ventilation—Windows more outwards in the Walls advantageous—Floors of, raiſed a Foot or more—Hip-Roofs preferable to Gable-Ends—Thickneſs of Walls according to Materials—When thin, eaſily penetrated by the Sun or Cold—Should be of good Thickneſs—Principal Objects in, Conveniences and Cheapneſs.—BARNS—Size and Conſtruction of, various—Where Throſhing-Machines and Stacking are in Uſe, large ones unneceſſary—Dimenſions larger where the Flail, and Houſing Grain, are practiſed—Slides neceſſary for the Admiſſion of Air—Conſtruction of Floors—Beſt of Oak Plank—Clay and other ſimilar Kinds of Floors liable to crack and break up—When formed of Plank, ſhould be ploughed and tongued, and have a Foundation of Brick-work—More ſecure and freer from Damps than when nailed to Sleepers—Floors of Brick nearly equal—Throſhing Floor—Twelve by eighteen Feet a good Size—Addition of Flues or Drying-Floors uſeful—Cow-Houſes, or other Offices, may frequently be provided on the Ground Floors—This Method has various Advantages—Leſs expenſive—Saves Room—Grain more ſecure—Chamber Barn Floors—Eaſier to throſh upon—Pitching-Holes uſeful in every Form of Barn—Unloading in the Barn more expeditious.—GRANARIES—Should be firmly built—Have extenſive Flooring—Contrived to avoid Labour—Effected by particular Conſtruction of Floors—Free Ventilation by latticed Windows

—*Spouts or Ventilators on the Top—A ſquare the beſt Form—Neceſſary to be placed on ſhort Poſts or Pillars of Stone—Should be lined with Boards cloſely joined together—Outſide covered with Weather-boarding—In common Granaries, Attention not neceſſary to all theſe Points—Need not be ſo ſtrongly built—Moſt proper Situation in the Barn where houſing Grain is not practiſed—Machinery for raiſing the Corn neceſſary.—*STABLES*—Elegance not requiſite in—Comfortable and convenient ones neceſſary—Should be ſo contrived as to preſerve nearly an Equality of Temperature at different Seaſons—Muſt be provided with proper Drains for the Removal of Moiſture—Moveable Shutters, as Windows, ſave Expence—Racks and Mangers—Economy and Convenience in Conſtruction of—Large ones diſadvantageous—Should have a more perpendicular Poſition than uſual—Placed conveniently in Niches in Walls—Sparred at Bottom to admit Hay-Seeds—Conveniences to collect them uſeful—Hatches ſave Time in feeding—Mangers need not be the Width of Stalls—Small Boxes convenient for—Cheap Method of forming Stalls and Racks—In this Way ſparred at Bottom—Hay-ſeed Box neceſſary—Single Stalls better than double—Attention neceſſary in paving Stables—Should approach to a Level—Moiſture removed by ſmall Middle-Drain—All the Drains to empty into a large one—Stall Drains covered by perforated Oak Planks—Main Drains placed at Ends or Bottoms of Stalls—Shallow open Drains leſs expenſive—Pavement of Stalls ſhould have very ſlight Inclination to Drains—Advantages gained by this Conſtruction of Stalls—Size of Stalls—Five Feet a good one—Diviſions of ſhould be high—For Stallions and young Horſes ſparred to the Top—Or divided by Doors hung to back Poſts of Stables—Latter Method uſeful for Mares and Foals—Harneſs Place near the Stable neceſſary—Situation for Corn-Bin—When placed above ſhould feed by a Spout in Stable—This Mode has Advantages.—*COW AND FEEDING HOUSES*—Nearly ſimilar—Calf-Pens in them ſometimes—A Plan not to be adopted—Better at a ſmall Diſtance—May be contrived to ſuit either Purpoſe—In the Form of ſingle or double Sheds—Muſt be capable of free Ventilation—Require little Labour in cleaning—Have Drains to keep the Cattle dry—Free Circulation of Air neceſſary in—Without it Cattle liable to Diſeaſe.—Sheds open behind ſometimes uſeful—Air-Holes in Roofs occaſionally neceſſary—Windows in Gable-Ends frequently uſeful—Advantages of ſuch Means—Feeding of Animals promoted in this Way—Modes of Conſtruction—Circumſtances to be attended to in—Common Method injudicious—Feeding from Holes without—Objections to—Moſt convenient Plan of, in ſingle Sheds—Double ones more economical and uſeful—Leſs Extent of Building, neceſſary in—Leſs Deſtruction of Fodder—Room over uſeful in all Sheds—An intelligent Feeder's Opinion on—Double Sheds not ſuppoſed ſo advantageous—Rooms over prejudicial—Plan recommended by him—Room in the Middle of, neceſſary—Keeping Cattle clean and dry, Uſes of—Contrivances for leſſening Labour eſſential—Means of doing which—Attention to paving Stalls neceſſary—This frequently not done—Double Stalls uſeful—The Expence of greater—In many Caſes unneceſſary—Conveniences for Food and Water neceſſary—Drains and Reſervoirs ſhould conſtantly be formed.—*CALF-PENS*—Situation of—Near Cow-Houſe—Mode of laying Floors of—Diſagreeable Effluvia thus avoided—Moveable Diviſions in, uſeful—Troughs and Racks ſometimes neceſſary—Food more equally diſtributed by them—In general not requiſite.—*DAIRIES*—Advantages of good ones—Are of different Kinds—Conſtruction of each—Proper Situation of—Moſt advantageous covering of—Thatch uſeful for—Stone Walls always preferable—Proper Height of Ceilings of—High Win-*

*dows neceſſary—Should have Frames with Gauze ſtretched on them—Utility of—Floors of—Beſt Sort of Materials for—Proper Manner to be laid—Well near neceſſary—Mode of fitting up—Veſſels for—Of different Materials—Lead—Marble—Slate ones made by Mr. Hind at Swithland, near Leiceſter—Firſt muſt be kept clean—Plugs and Cocks neceſſary for Coolers—Large Cock for Water requiſite—Flues for conducting Heat ſometimes neceſſary in them—Circumſtances to be attended to in Ceilings and Walls—Churning-Room near the Milk-Houſe—Fire-Place neceſſary where Utenſils are kept—Stone Slabs or Strips of Wood neceſſary on outſide of—Smoking of Chimneys in, prejudicial—Cheeſe-Dairy—Milk-Houſe for nearly ſimilar—Here ſometimes uſeful to have Milk-Shelves—Preſſing or Scalding Houſe on ſame Plan as for Churning—Should always have a good Preſs in—Salting-Room—Laid with Flags—Strong Table and Shelf neceſſary—Cheeſe-Room—Beſt over the Dairy—Commonly above Cow-Houſe or Kitchen—Reaſons of.—*SHEDS*—Highly convenient—Modes of conſtructing them—Uſeful for various Purpoſes.—*STRAW-HOUSES*—Frequently uſeful—Save Straw and Time—Prevent Litter.—*ROOT-HOUSES*—Neceſſary to the Supply of Winter Food—Roots or other Vegetables.—*POULTRY-HOUSES*—Circumſtances in Conſtruction of.—*HOG-STIES*—Mode of conſtructing them—Troughs contrived to prevent Waſte of Food—Boilers for preparing Food, ſometimes requiſite in.—*COAL AND WOOD HOUSES*—Moſt uſeful Conſtruction of.—*WORK-SHOPS*—Utility of.—*TOOL-HOUSES*—Circumſtances to be attended to, in.—*STORE-ROOMS*—Situation for—Various Uſes of.—*FARM SERVANTS' ROOMS*—Neceſſary on large Farms—Advantages of—Beſt Situation for—Ground-Floors of Stone or Brick—Upper ones of Plaſter or Brick—Mode of forming them—Arrangement of Beds—Free Circulation of Air in, neceſſary.—*PIGEON-HOUSES*—Should be large and roomy—Beſt Situation of—Form of, not material—Sort of Covering neceſſary for—Should be ſecure againſt Vermin—Conſtruction of, when built ſeparately—May have Sheds under them—Objections to Wood-Coats—Entrances of ſhould face the South—Large Holes improper—Weather-Boards above them neceſſary—Methods of forming the Neſts.—Forms of—Sheds the beſt—Proper Situation of.—*CONVENIENCES FOR PREPARING CATTLE-FOOD*—Advantages of in feeding Animals.—*STEAM BOILERS*—Uſeful in various Ways—Deſcription of—Other Contrivances propoſed---Uſeful for other Purpoſes.---*CORN CHESTS*---Neceſſary and economical---Small Tub ſometimes ſufficient---Beſt Conſtruction of---That of the Granary uſeful on large Farms.---*CORN STANDS*---Conſtruction of, various---Beſt Mode of---Form of the Duke of Bedford's at Woburn Abbey---Peculiar Circumſtances in the Formation of---Materials moſt proper for---Slates or Flags ſometimes uſed for Bottoms of---Not neceſſary when the Foundation is well laid---This kind of Stand uſed by Mr. Bakewell.—*BEE STANDS*.---*FARM HOUSES AND OFFICES*---Situation and Arrangement of---Moſt economical in ſaving Labour---Proper Situation of---Near the Centre of Farm---A Square the moſt proper—Offices erected on expoſed Sides of---Not attended to in building Farm-Houſes---Theſe ſhould be at a Diſtance from Offices---Sometimes ſuch as to overlook the Operations going on---Muſt be adapted to the Buſineſs---Nature of Ground frequently points out Situations---General Obſervations on the Expence of Farm Buildings.—Eſtimates of.*

IN the conſtruction of farm-houſes, and other buildings neceſſary for the economical and advantageous management of farms, too little attention ſeems hitherto to have been paid, conſidering the great practical importance of ſuch objects. It is obvious,

however, that the facility and convenience of carrying on different operations muſt greatly depend on the judicious form and arrangement of ſuch erections. By the commodious diſtribution of ſuch buildings, ſervants are enabled to perform more labour, and with greater eaſe to themſelves; as where offices are injudiciouſly placed, much of their time muſt, of neceſſity, be loſt in the conveyance of different articles, ſuch as fodder, ſtraw, &c. from one place to another.

The ſize of farm buildings ſhould in general be proportioned in ſome meaſure to that of the farm, and their conſtruction be regulated by its nature and ſituation. Where the farm is merely a grazing one, fewer buildings are required, and theſe are chiefly of the ſhed kind, which may be formed in a cheap manner, of ſuch materials as are neareſt at hand, or can be eaſily procured. In ſuch caſes the ſheds ſhould, however, always have permanent roofs, except they are built in the fields for ſummer uſe only. On thoſe grazing farms where the cattle are only houſed during the winter, or where a greater number of buildings are employed in winter than in the ſummer, much expence in roofing ſuch ſheds may frequently be ſaved by erecting walls only, and fixing merely temporary coverings to them for the ſhelter of the cattle; or by having poſts framed, and placed in ſuch a way as to ſupport hay-ricks, or any other ſort of rick not to be removed during the winter. By this means a warm roof is afforded, and a convenient ſituation given for the ſtacks. This, however, from its being a paltry and ſlovenly method, is only to be had recourſe to under particular circumſtances, as where a better ſort of cattle ſhed cannot with propriety be built.

On ſuch ſorts of farms, different ſorts of ſheds ſhould conſtantly be provided for different kinds of cattle: where they are intended for ſtore ſtock only, they ſhould be open on one ſide, as the cattle ſhould be kept cool, otherwiſe they are apt to take cold when they are turned out, which they ſhould always be every day when the weather is tolerable; but if they are intended for feeding cattle, they ſhould be made much warmer, as in that caſe the cattle will thrive faſter, and there is no neceſſity for turning them out, ſo that the danger of their taking cold is avoided.

Different accommodations from theſe will be neceſſary for dairy-farms, they being moſtly compoſed partly of grazing and partly of arable land. On theſe the cow-houſes ſhould be ſo regulated as to ſuit the number of cows that can at any time be kept; and ſuch other conveniences ſhould be provided as are proper for the dairy buſineſs, whether they be managed as cheeſe, butter, milk, or ſuckling farms. For ſuch farms ſmall ſtables and barns are, in general, ſufficient.

And for the arable or corn farm, as partaking in general of both the other ſorts, the offices and buildings ſhould not only be much more numerous, but calculated to

ſuit the various purpoſes of each. The ſtables ſhould be ſufficiently large and convenient, for the accommodation of ſuch a number of horſes as may at any time be employed in the labour of the farm; and the cow and feeding houſes adapted to the quantity and kind of cattle kept or fed. The barn and granary muſt alſo be proportioned to the extent of ground under arable cultivation. Where thraſhing-machines are to be erected, the ſize of the barns need not be ſo great as in other caſes; as neither the height neceſſary for the flail, nor room for a large quantity of corn in the ſtraw, are required. Beſides, theſe machines not demanding much elevation in the buildings where they are placed, a granary and ſtore-room may often very conveniently be made above them, which cannot be done where the barn is required to be high.

On this kind of farm convenient buildings ſhould alſo be prepared for the breeding and management of young animals of different ſorts, ſuch as horſes, cattle, hogs, poultry, &c.

FARM-HOUSES.

The dimenſions of the farm-houſe, like moſt of the other buildings, ſhould, in a great meaſure, be regulated by the extent of the farm. It ſhould be neat, airy, and have ſufficient accommodations both for the family of the farmer, and the buſineſs that is to be performed in it. On the ground-floor there ought, at leaſt, to be a good parlour and kitchen, with back kitchen, which may ſerve alſo for a bake-houſe and brew-houſe, with cloſets and other convenient places for depoſiting different articles: and likewiſe a dairy, pantry, and a proper place for the purpoſe of a cellar.

The upper part may be divided into lodging-rooms or bed-chambers, which ſhould be rather large, in order that the circulation of air may be free and unreſtrained. The windows are better to be tolerably large than ſo ſmall as they are commonly made, and the ſaſhes placed nearer the outſides of the walls; for it is evidently a miſtake that they are better preſerved from the effects of the weather by having them ſet ſo much within the wall as is uſually the caſe, as the wet cannot be ſo readily dried up. By not properly attending to theſe circumſtances, the appearance of houſes of this kind are frequently rendered gloomy and unpleaſant. It will alſo be of great advantage in reſpect to health and cleanlineſs, to have the ground-floors raiſed ſixteen or eighteen inches above the ſurface of the ground. The kind of roof ſhould be determined by the expence of materials and other circumſtances; but hip-roofs, with vents within the buildings, as being cheap, are,

probably, in general to be preferred to thoſe where gable ends are had recourſe to. It is juſtly obſerved by a late author, that hip-roofs require no more materials, while gable-ends cauſe more expence of building, and an unneceſſary accumulation of weight upon the end walls; and that vents made within-ſide of the houſe are not only leſs liable to ſmoke than when in an outſide wall, but contribute much to keep the houſe warm, by acting in ſome manner as flues, and diffuſing heat more or leſs throughout the whole houſe *.

The thickneſs of walls, as well as many other circumſtances, muſt depend on the eaſe and convenience of procuring materials: where rough ſtone walls are made, the thickneſs may be about eighteen inches or two feet; but where the ſtones are good and properly formed for building with, or where bricks are employed, they may be made much thinner; it ſhould, however, be remembered, that when they are too thin, they are readily penetrated by the heat of the ſun in ſummer, and by cold in winter. Such houſes ought, therefore, always to be built of ſuch a thickneſs as to prevent the effects of theſe as much as poſſible.

In the conſtructing of houſes for the purpoſes of farming, it is evident that conſiderable latitude muſt be given, but, as architectural ornaments are not much wanted, the principal points to be attended to would ſeem to be thoſe of providing ſufficient conveniences without incurring great expence. Such buildings ſhould be cheap and ſimple in their form, and have a regularity of appearance.

BARNS.

It is obvious from what has been already advanced, that the ſize and conſtruction of barns muſt be varied in ſome meaſure, according to the cuſtoms and ſituations of the places where they are to be erected. Where thraſhing machines, and the practice of ſtacking, are properly held in eſtimation, large barns are quite unneceſſary; but on ſmall farms, and where a preference is given to the uſe of the flail, and the ſtoring of the crops in barns inſtead of ſtacks, they ſhould be of conſiderably larger dimenſions, in order, not only to admit the neceſſary quantity of grain to be depoſited in them, but to allow ſufficient room for the free uſe of the flail. In ſuch caſes they ſhould not, perhaps, be leſs than eighteen or twenty feet wide, with height and length proportioned to the quantity of materials that are to be ſtowed. Air ſhould likewiſe be pretty freely admitted into them on different ſides by means of ſlides or other contrivances. The conſtruction of the floors ſhould be par-

* Beatſon's Paper in Communications to the Board of Agriculture, vol. I.

ticularly attended to, in order that they may be firm and dry: the firſt purpoſe is probably beſt obtained by making them of good oak plank; floors formed of clay, and other ſubſtances of a ſimilar kind, being liable to crack and be broken up by the different operations that are performed upon them. When floors are made with planks, it is a good method to lay them upon a foundation of bricks, and unite the different planks by ploughing and tonguing. In this way floors are made more ſecure, and freer from damps, than where they are nailed down to ſleepers. The ſize of the thraſhing-floors of barns muſt vary according to circumſtances; but twelve feet by eighteen would ſeem in general to be a good proportion. It has been obſerved to me by an experienced agriculturiſt, that next to oak planks, and nearly equal for thraſhing floors, are bricks made of good tempered clay well burned, made four inches thick, and laid edgeways with well-beaten mortar. The addition of flues and floors for the purpoſe of drying might alſo be ſometimes conveniently employed, and would frequently be found advantageous in moiſt and damp ſeaſons.

Where the ſituation of the ground and other circumſtances will permit, cow-houſes and other farm offices may be provided on the ground-floors, the barns, hay-chambers, &c. being above. The advantages of this mode of conſtruction are, that it ſaves much expence in buildings, and occupies but little room, while the grain is in leſs danger of being ſpoiled by the introduction of dirt or other hurtful ſubſtances from the farm-yard, and more ſecure from the depredations of hogs, poultry, &c. Chamber barn-floors are alſo ſaid to be more convenient and eaſy for thraſhing upon. Theſe kinds of barns can only, however, be adapted to ſmall farms, and then perhaps may often be ſaid to be attended with inconvenience.

In whatever manner thoſe barns are built that are intended for containing large quantities of different crops, they ſhould conſtantly be provided with convenient pitching holes for houſing them at, as by this means the danger of injuring the floors by heavy carriages being drawn upon them, is avoided, and there is not any neceſſity for thoſe large and expenſive doors that have been in common uſe: little injury will, however, be done to the floors by drawing the loads of grain upon them, when they are kept well littered with ſtraw; and a man will unload nearly two loads of grain, when drawn into the barn and unloaded upon the mow, while he could unload one at a pitch-hole.

GRANARIES.

The great object in theſe buildings being the preſervation of a large quantity of grain in a narrow compaſs, they ſhould not only be ſtrongly built, but be provided

with a great extent of flooring on which the corn may be ſpread; and as frequent ſtirring or turning is neceſſary for the ſafety of the grain, it is obviouſly of much importance to have them ſo contrived, that a great deal of the manual labour attending ſuch operations may be avoided. This is done, in ſome caſes, by having them conſtructed with different floors placed in ſuch ſloping directions that the corn has a tendency to the centre, and is let out by means of ſliding ſhutters; in others the ſame advantage is gained by a number of hoppers, ſituated in ſuch a way as to allow of the grain being moved by merely drawing a ſlider at the bottom of the granary. Sufficient ventilation, which is highly neceſſary in theſe buildings, is, in ſome inſtances, provided by having ſmall windows ſtrongly latticed and covered with wire, as well as ſtout ſhutters cloſe to the ceilings, and in others a free circulation of air is given by means of a number of air-holes and ſpouts, diſpoſed in horizontal poſitions acroſs the buildings. Where it is neceſſary that the air ſhould likewiſe paſs upwards, that direction may be readily given it by having a ventilator on the top of the granary.

The moſt convenient form for buildings of this ſort is probably that of a ſquare, the ſize of which may be about fourteen feet. They ſhould when built ſeparately ſtand on a ſufficient number of ſtrong poſts, or pillars of ſtone, about four or ſix feet above the ſurface of the ground, having very ſtrong wooden frames, the inſides of which muſt be filled up with bricks. The girders, joiſts, and flooring, ſhould be firm and ſtrong, that they may not give way by the great weight of the grain. The whole of the inſide is rendered the moſt complete, by being lined with dry oak, or good deal boards, cloſely jointed together, and the outſide covered over with ſtrong weather-boarding, well nailed to the timber-work of the frame, and properly payed over with pitch or tar-varniſh.

But in conſtructing granaries where the accommodation of the farm is the only object, it is quite unneceſſary to pay attention to all theſe circumſtances, as a large quantity of thraſhed grain is ſeldom kept. Neither the ſame ſtrength or expence of building is required as for thoſe in which large ſupplies of corn are depoſited. It is proper, however, in moſt caſes, that a place of ſafety for corn ſufficient for the reception of one half of the annual produce of the farm ſhould be provided. Where the cuſtom of houſing grain prevails, there is ſeldom room enough left for erecting a granary within the barn; but where that practice is not regarded, and eſpecially where there is a thraſhing-machine, the beſt and moſt convenient ſituation for it is the barn; proper tackle and conveniences for hoiſting up the corn being provided.

STABLES.

In the conſtruction and fitting up of ſtables for farm-horſes, it is not neceſſary to attend ſo particularly to elegance, as in thoſe which are intended for the reception of horſes of other deſcriptions. It is, perhaps, ſufficient to provide them comfortable and convenient habitations; working horſes ſhould not, however, be kept in ſuch low dirty hovels as they frequently are, as nothing tends ſo much to the keeping of theſe animals in health, as their having dry, clean, and well ventilated ſtables. They ſhould, therefore, be conſtructed in ſuch a manner as to keep out the ſevere cold of winter, and the intenſe heat of ſummer, and be provided with proper drains for conveying away every kind of moiſture and naſtineſs. The number and ſize of the windows ſhould be proportioned to the extent of the ſtable, and be ſo contrived as to open and ſhut at pleaſure. When it is neceſſary to ſave expence, ſhutters may be adapted to, and ſuſpended in the windows by iron-pins, on which they may be turned as occaſion requires.

In the contriving of racks and mangers, regard ſhould be had to economy and convenience. The common and too general mode of making them extend quite acroſs the upper end of the ſtall, is not only a bad, but by no means a cheap method of conſtructing them. Beſides, in order to ſave trouble, ſervants are extremely apt to ſtuff racks full of hay, however large they may be; from which various bad conſequences proceed, and much hay is waſted and deſtroyed by being either pulled down and mixed with the litter, or trodden under the feet of the horſes.

The pernicious effects reſulting from the practice of ſuffering horſes to be continually ſtuffing themſelves with hay, are well known to thoſe who are acquainted with the proper management of ſuch animals, under whoſe directions they are never allowed to have much hay in their racks at a time. There is alſo another diſadvantage in this plan of fitting up ſtalls, eſpecially to farmers, as it ought to be their object to preſerve every thing;—the hay-ſeeds are totally loſt, which if good, and carefully ſecured, might be of great utility and value. By the racks having ſo much inclination outwards, the ſeeds are alſo extremely apt to fall into the horſes' ears and eyes, which often produce diſagreeable effects. From theſe conſiderations it would ſeem that racks ſhould have a more perpendicular direction than is commonly given them, not having a ſpace of more than fourteen or ſixteen inches from the wall; the bottom ſhould alſo be ſparred, in order to let the ſeeds fall down below, whence they may be removed by a ſliding ſhutter or ſmall door. The ſame advantages may

alſo be obtained by leaving niches in the walls for the racks, on which plan the ſpars will be equal with the inſides of the walls. If the niches and racks be made in the middle of the ſtalls, two feet, or two feet and a half wide, will in moſt caſes be ſufficient; they ſhould, however, be carried down low enough to admit of a ſmall box or drawer being placed under them, for the reception of the hay-ſeeds. Racks of this ſort may likewiſe be placed in the corners of the ſtalls, and be made in ſuch a way as that one nich may ſerve two ſtalls. They may alſo be placed in the angles of the ſtalls without having any nich, and be made of a ſemicircular form. But in whatever way they are made, there ſhould conſtantly be a diviſion betwixt them, which is probably beſt made of deal. By this means the farmer will be able to know, with preciſion, what each horſe eats, which cannot be done in any other way. Where the racks are put in the corners of the ſtalls, it may, perhaps, be more advantageous to have them ſtraight than circular; but in whichever way they are formed, the farmer ſhould always have a hatch fixed for each ſtall, as by that means a great deal of time may be ſaved in feeding his horſes.

It is equally unneceſſary in the making of the manger to have it the ſame width of the ſtall; as a box or drawer ſixteen or eighteen inches long, and twelve or fourteen inches wide, will anſwer every purpoſe. It ſhould be ſo contrived that it may be readily taken out and cleaned whenever it is fouled or becomes furred with dirt. With the fixed mangers this can never be done, however they may be daubed by the ſaliva iſſuing from the horſe's mouth during the time of feeding, or the diſcharges proceeding from his noſtrils when labouring under colds, or other more dangerous diſorders.

There is another method of making ſtalls, which, as being cheaper and more economical, deſerves to be noticed: on this plan the ſtable has neither racks nor mangers; the head of the ſtall is boarded about three feet from the ground, having a ſpace of about two feet from the wall, in which the hay is to be depoſited, the horſe pulling his hay from below, inſtead of drawing it from above; which is not only more natural, but prevents the waſte of hay, much of which drops down and is loſt when the horſe eats from a rack; but, by this method, whatever falls is again received among that from which it was taken. But even on this conſtruction it will be neceſſary to have the bottom ſparred, within eight or ten inches of the ground, and a box, hopper, or hay-manger, and drawer, ſo contrived as to receive the ſeeds of the hay: where there are double ſtalls the boxes may be divided in the middle. Single ſtalls, where they can be conveniently made, ſhould, however, always be preferred as more ſafe.

Paving of ſtables is a matter of ſome importance, though it has been but little attended to: whether the ſtall ſhould have a ſlight declivity or be perfectly level, has not, perhaps, yet been fully determined. It would ſeem, however, to be more natural and eaſy for theſe animals to ſtand and reſt themſelves on a level ſurface, than on one that is ſloping, as it is obvious that the tendons, or ſinews of the paſtern joints, muſt be kept more upon the ſtretch in the latter, than the former caſe. The chief difficulty in reſpect to a level ſtall has been the conveying away of the moiſture. This may, however, be well accompliſhed by paving the ſtall quite level, and only leaving a ſmall drain in the middle, extending within two or three feet of the upper end of the ſtall. It ſhould not be more than ſeven or eight inches wide at top, forming an angle at the bottom. The depth of that end neareſt the head of the ſtall ſhould not be more than three or four inches deep, having as much ſlope as can be conveniently given it backwards, in order that it may carry the moiſture off quickly to the main drain, into which all the ſtall-drains ſhould empty themſelves.

The ſmall ſtall-drains ſhould be covered with a piece of good ſtrong oak-plank, in which a great number of holes are bored, and which is ſo faſtened as to admit of its being readily raiſed up and let down: by this means the drains may be waſhed and kept clean and ſweet.

Main drains may be made at the end of the ſtalls, or in any other convenient ſituation, for carrying off the moiſture into the general reſervoir. If they are placed at the bottom of the ſtalls, they ſhould not be cloſer to the ſtalls than two feet, in order that the ſtale of mares may get readily into them, which would not be the caſe if they were nearer, unleſs the pavement behind the ſtalls were made to decline a little towards them. Theſe drains need not be more than ſeven or eight inches wide at the top, but they ſhould be covered with plank, in which holes are perforated for conveying away the moiſture.

In order to ſave the expence of making main drains, a ſhallow open drain may be made in the common way, with which the ſtall drains may communicate by means of very ſmall grates at the ends.

The pavement or floors of the ſtalls ſhould have a very ſlight declination from their ſides towards the drains, to prevent any moiſture ſtanding on them; an inch, or an inch and half will, however, be quite ſufficient.

From having ſtalls conſtructed in this way, ſeveral advantages will be gained; the horſes, by ſtanding on a level, will be leſs liable to diſorders in the feet and heels, and from the great declivity of the drains the urine will be more readily carried away, and not be ſuffered to ſpread; and, of courſe, much litter be ſaved, which is a matter of conſiderable importance where ſtraw is ſcarce.

The ſizes of ſtalls are different, according to circumſtances; but four feet and a half are the leaſt they ſhould ever be made; five feet is much better. The diviſions between them ſhould be high, ſo that ſtrange horſes may not ſee each other. And where ſtallions are kept, or young horſes required to be left looſe in a ſtall, they ſhould be ſo incloſed as to be incapable of doing miſchief. For theſe purpoſes, one or more ſtalls may be ſparred to the top, or doors provided, which may be hung to the back poſts of the ſtable. Where this laſt method is followed, the ſtalls ſerve extremely well for keeping different mares and their foals ſeparate from others.

Either in the ſtables, or very contiguous to them, a place ſhould always be provided for the reception of harneſs and other articles of the ſame kind; and likewiſe a ſuitable and well-ſecured place for a corn-bin. If the ſtable be ſmall, and it is, of courſe, the moſt convenient to have the corn-bin in the room above, it ſhould be ſo conſtructed as that the proper feed may be regulated and received from a ſpout in the lower part of the ſtable. This method ſaves much time and trouble in going to the bin, meaſuring, &c. as well as in many inſtances much corn *.

COW-HOUSES AND *FEEDING-HOUSES.*

As these buildings reſemble each other in many reſpects, they may be deſcribed under the ſame head. In ſome cow-houſes there are, however, an addition of calf-pens, and ſlight differences in the conſtruction of the ſtalls. But although the having calf-pens in the cow-houſe may occaſionally ſave trouble in carrying milk, it is a plan by no means to be generally adopted, as it cauſes much uneaſineſs to the cows, and prevents their giving their milk properly, or ſufficient in quantity. It is a much preferable method to have the calves ſo placed, or at ſuch a diſtance, that the cows cannot be diſturbed by their cries, as by theſe means the cows will not only much ſooner forget their calves, but feed the better, and afford a larger ſupply of milk.

Cow-houſes, or feeding-houſes, by a very little management in building them, may be ſo contrived as to ſuit either purpoſe, as neceſſity may require. They may either be made in the form of ſingle or double ſheds, but the latter is probably the better method, as by that means a great number of cattle may be well accommodated at a trifling expence of building. The principal points to be attended to in conſtructing theſe buildings are, that they be capable of free and eaſy ventilation; that they require little labour in adminiſtering the food and clearing away the excrement;

* Communications to the Board of Agriculture vol.

and that the ſtalls be ſo contrived as to keep the cattle perfectly dry, airy, and cool, and have convenient and ſuitable drains and reſervoirs for the reception of urine and dung.

Thoſe who have had much experience in the management of cows, know that a free circulation of air is as highly neceſſary in theſe houſes as in ſtables. In low and cloſe buildings, where a great number of cows are put together, they are extremely liable to be diſordered by the condenſed perſpiration and fumes ariſing from their reſpiration, as well as from the cold proceeding from the quick evaporation that takes places in ſuch caſes.

In this way cattle are frequently prevented from fattening ſo expeditiouſly as they otherwiſe would do. Where many cattle are together, the ſheds in which they are kept would, perhaps, be beſt quite open behind them, except for feeding cattle, which are well known to thrive faſter when kept rather warmer.

When more free ventilation is neceſſary, which is ſhown by the wetneſs of the timbers above, it is probably the beſt way to procure it by making additional air-holes in the roofs or other convenient places of the buildings. Where there are gable-ends, windows may be made high up in them, with moveable boards ſo contrived that they can be opened or ſhut as occaſion may require. By theſe means advantages are gained, not only in reſpect to the health and fattening of the animals, but the duration of the building itſelf; for wood which is frequently wetted and dried in the way we have juſt noticed, decays with aſtoniſhing rapidity.

As any one the leaſt acquainted with the animal economy muſt know that it is utterly impoſſible for ſuch cattle as are kept in a ſtate of conſtant exceſſive perſpiration to feed well, and conſequently get fat with expedition, which are the circumſtances on which the farmer's profit and advantage greatly depend, more attention ſhould certainly be paid to theſe matters. An extenſive feeder in one of the midland diſtricts, however, aſſures us that he has, from long experience, always found ſuch cattle as feed the quickeſt, whether within doors or without, to be thoſe which are generally in a ſtate of moderate perſpiration.

In regard to the moſt convenient plan of conſtruction for ſaving expence in labour, and for allowing of the moſt ready and expeditious mode of clearing away the dirt and naſtineſs which is produced, there are many things to be attended to, but chiefly thoſe of the form and arrangement of the internal parts. It is a very common method to have poſts placed along the ſides of the wall at the diſtance of about three feet from each other, to which the cattle are faſtened; a ſpace of three or four feet being left next the wall for the reception of the food. This

is, however, a very injudicious method, becauſe the feeder is conſtantly under the neceſſity of going among the cattle in order to give them their food; except, indeed, where they are fed from the outſides of the building, which is both an inconvenient and tedious method of proceeding. In feeding from without too, through holes made on purpoſe, there are many objections. At ſome periods, as in rainy weather, and when there is a great fall of ſnow, it will be almoſt impoſſible to give them their provender.

The moſt eaſy method to avoid theſe inconveniences in ſingle ſheds, is to leave a ſufficient ſpace before the heads of the cattle for the feeder to go, with ſuch vehicles as contain the food, by which means he will be enabled to diſtribute it with facility. In double-ſheds, which are unqueſtionably the moſt proper, economical, and convenient buildings, the ſame advantages are obtained by making the cattle to face one another, and leaving a ſpace of about four feet as a paſſage for the perſon who feeds them. By this arrangement a leſs extent of building is neceſſary, and much leſs deſtruction of fodder incurred, eſpecially where a loft is provided in the roof for depoſiting the provender, and other purpoſes. This ſhould alſo be done in the ſingle ſheds, and the eaſieſt mode is that of having covers or doors opening by means of hinges without, by which the different articles of food may at once be thrown in from the cart or waggon. In theſe caſes the ſheds ought, perhaps, to be a little higher than they are commonly made, and the inſide be covered above the cattle with boards. But double-ſheds, a very intelligent feeder aſſures me, are not only the moſt improper and inconvenient, but the leaſt economical, and moſt expenſive in their conſtruction; being attended with many inconveniences, and no advantage, that he knows of, except that of ſaving a little, and but a little, room. Sheds for cattle ſhould never, he thinks, have lofts over them, as by that means the cattle are kept too warm and cloſe; and unleſs the floor over them is quite cloſe, which is ſtill worſe for the cattle, the fodder that is laid there is frequently ſpoiled by their breath. He would always recommend ſingle-ſheds open behind, about twelve feet within, including a gang-way of two feet before the heads of the cattle, for the purpoſe of feeding them: three feet, or three feet two inches, he has always found ſufficient ſpace for each beaſt, except they be very large indeed. It is alſo very convenient, he ſays, to have a ſmall room, about the middle of the ſide of the ſhed, with a door into the gang-way, for the purpoſe of getting the hay into from the ſtacks, which ſhould be placed as near thereto as poſſible.

The keeping of cattle clean, dry, and free from diſagreeable effluvia, is not only a buſineſs which demands much attention, in ſo far as it tends to preſerve their health, but which intereſts the farmer in a high degree, from its taking up much

time that might be otherwiſe employed. It is therefore of the greateſt importance to have theſe kinds of buildings ſo contrived that they may require as little labour as poſſible in removing dung, &c. Theſe things ſhould, therefore, particularly occupy the minds of perſons employed in making ſuch erections. Where, from ſituation and other circumſtances, a convenient place can be provided behind the cattle, for depoſiting the dung at once, it will be by far the beſt way, as much labour and expence in wheeling, &c. will be ſaved, and the dung will not be injured by it. Beſides it will be prevented from being ſcattered about the farm-yard, by which conſiderable loſs is often ſuſtained.

The proper conſtruction and paving of ſtalls tend very materially to render the cleaning of cattle eaſy and expeditious; though in ſome places ſtalls are ſcarcely employed at all; the cattle either not being bound, or merely bound to ſtakes without any diviſions being made betwixt them, while in others they are confined ſeparately in narrow ſtalls by rails, or the ſtalls are made with only ſhort diviſions. Double-ſtalls properly divided, and boarded ſufficiently high to prevent the cattle from looking over them, are, in general, to be preferred; but ſtalls of this kind are certainly more expenſive, and in many inſtances unneceſſary. In feeding-houſes each ſtake ſhould have a box or trough for meat, and in the middle a convenience for holding water, in order to ſerve the beaſts on each ſide, which, in many inſtances, may be filled by means of a pipe from a ciſtern, or other place where water is kept. Theſe boxes or troughs may be made of either wood or ſtone, and be joined together or ſeparate, as may be thought the moſt convenient. Above theſe troughs a perpendicular rack ſhould be placed for containing hay, ſtraw, &c.

In paving the ſtalls, the ſame directions ſhould be attended to as in that of ſtables; for where cow-ſtalls are paved with too great a declination, the animals always ſtand in a very uneaſy and uncomfortable manner, which is very prejudicial to their becoming fat, or feeding well.

Proper drains and reſervoirs for the reception of urine, &c. are alſo of the greateſt conſequence, as without them it is utterly impoſſible to preſerve the animals that are kept in ſuch houſes, ſo ſufficiently clean and ſweet as is neceſſary. Beſides the moiſture or juice, which is continually iſſuing from dung and other ſubſtances in a ſtate of diſſolution, muſt be received and detained in them, or the farmer will ſuſtain conſiderable loſs in point of manure.

CALF-PENS.

In the conſtruction of calf-pens there are a few things that ought be kept in

the mind of the builder. Though they ſhould not be ſituated in the cow-houſe, they ought not to be at an inconvenient diſtance from it. Great attention ſhould likewiſe be paid in laying the floors, as it is of much importance in rearing ſuch animals to keep them dry and warm. Calves, when intended for rearing, ſhould always be kept dry and airy, and rather cool, or at leaſt not over warm. By laying ſpars about two inches broad upon joiſts, at the diſtance of two inches from each other, ſo as to raiſe the floors two or three feet from the ground, according to ſituation, they will not only be kept perfectly dry, as the moiſture will be drained off, but freſh air will be admitted under the floor, by which means the noxious unpleaſant ſmells too frequently met with in calf-houſes, will be removed. It would alſo be a good practice to have ſtalls or diviſions in the calf-pens, ſo that each calf might be kept ſeparate, by which means they would be much ſooner fattened, and more ſecure from miſchief. Partitions, if about three feet high, and made of any thin light wood, might be ſo contrived as to be moveable at pleaſure, and capable of being increaſed or diminiſhed according to circumſtances. In theſe pens, ſmall round troughs may be placed for the reception of milk, where the calves are intended for rearing, and ſlight racks for a little hay in the higher parts of them. By theſe contrivances the food would be more equally, and more certainly adminiſtered to theſe animals *. Where great numbers of calves are rearing at the ſame time, contrivances might be adapted for ſupplying all the different veſſels at once, and with certain quantities of food, but this is not generally neceſſary.

DAIRIES.

The advantages of good dairy management are, in common, ſo great, that every farm ſhould have ſuitable accommodations for carrying it on in a degree proportioned to their kind and extent. Dairies are of three different kinds: the butter, the cheeſe, and the milk dairy. The laſt is principally in uſe near large towns, where the milk is carried as ſoon as poſſible to be ſold. A good butter-dairy ſhould have three apartments: a milk-houſe; a churning-houſe, in which there ſhould be a proper boiler, and other conveniences for ſcalding and waſhing the veſſels; and a place for keeping them in, as well as for drying them, when they cannot be put out of doors.

The cheeſe-dairy ſhould alſo conſiſt of the ſame number of rooms, namely, the milk-houſe, the ſcalding and preſſing houſe, and the ſalting-houſe. The cheeſe-room

* Beatſon in Communications to the Board of Agriculture, vol. I.

is commonly at a diſtance, but it might be very conveniently made over the dairy. For the milk-dairy, a good milk-houſe, and a convenient place for ſcalding, cleaning, and keeping the utenſils in, that they may be ſweet, are only neceſſary.

As a proper temperature of the air is of very great importance, the ſituation of the dairy ſhould be ſuch as that it may not be expoſed too much to the heat of the ſun in ſummer, or the coldneſs of the air in winter. The inconveniences attending the latter being, however, more eaſily removed than thoſe of the former, a northern expoſure ſhould be preferred, and one which is covered as much as poſſible by the ſhade of trees or houſes. If ſituated ſo that the ſun has no influence on any part of it, it is the better. Where no rooms are made above the dairy, the covering may be of thatch placed over tiles; but it is better to have rooms above, in which caſe the nature of the covering is not of ſo much conſequence. Thatch covering, in ſuch caſes, is however certainly the beſt, as being the warmeſt in winter, and cooleſt in ſummer; but tiles in theſe circumſtances are unneceſſary, and they prevent the thatch from being properly faſtened to the roof, and by that means to be liable to be blown off. The thatch ſhould be properly parged with lime-mortar on the inſide, to prevent any duſt falling upon the milk.

Stone walls are always to be preferred in ſuch buildings to brick, as being leſs permeable to the heat of ſummer, and the coldneſs of winter.

In regard to the proper height of the ceilings of dairies, different opinions are maintained. Eight feet, or eight feet and a half, would ſeem to be a ſufficient height for every purpoſe. But of whatever height the ceiling of the dairy be made, the windows ſhould always reach to the top, in order to prevent the ſtagnation of air near it, and be latticed, with ſlight frames adapted to them, on which gauze muſt be ſtretched, to permit a free circulation of air, and at the ſame time keep out flies, and other animals of the ſame kind.

Free-ſtone flags are the moſt ſuitable for floors. They ſhould be made quite ſmooth, and well jointed; but where theſe cannot be had, or are too expenſive, ſquare paving bricks, well laid and jointed, may anſwer tolerably well. Marble and other expenſive ſubſtances are ſometimes employed, but they come much too high to be uſed in common dairies; but of whatever materials the floor may be compoſed, it ſhould always be laid in ſuch a manner as to decline towards the middle, or ſome other more convenient part, for taking off the water with which it may be waſhed or flooded in hot ſeaſons. There ſhould be a well, with a pump, for this and other purpoſes, either in the dairy, or as near to it as poſſible.

If the dairy be ſmall, it will be ſufficient to have it fitted up with neat ſhelves, for the reception of the veſſels that contain the milk; but where it is on a large and

extenſive ſcale, it may be fitted up with ſuch ciſterns or coolers as are ſufficient to contain a meal's milk, when not allowed to be deeper than three inches. They may be lined with lead, or made of marble or ſlate, where it is to be had; excellent ones are made by Mr. Hind, at the Slate Pits, at Swithland, near Leiceſter, of the laſt ſort of material; but from the former there will be little danger, if they be kept ſufficiently clean*. Theſe coolers ſhould be furniſhed with a plug at the bottom, and a cock to let out the milk, or the water when they are waſhed. At the backs of them, too, there ſhould be cocks for the purpoſe of letting in water to clean them with. A large cock ought likewiſe to be placed in ſome convenient part of the dairy for letting water upon the floor when it is neceſſary to clean it, and cool it in hot ſeaſons.

With a view to afford a neceſſary degree of heat in the winter ſeaſon, flues may be made to proceed from the fires either in the churning-room, or the place where the utenſils are dried and kept in proper condition. Theſe flues ought to be conſtructed in ſuch a manner that the heat may be regulated as occaſion requires, or wholly ſtopped if neceſſary.

Both the walls and the ceiling ſhould be ſo plaſtered that there may be no cracks or crevices for the lodging of duſt or inſects. Sometimes a part or the whole of the wall above the coolers is ſet with ſmall glazed Dutch tiles, which gives the dairy a neat and clean appearance.

The room for churning in ſhould be as near as poſſible to the milk-houſe, and be provided with a fire-place and furnace, and alſo a proper boiler for heating water to ſcald the different veſſels, as well as other purpoſes. It is an additional convenience if a pump can be had, with ſuitable contrivances to it for filling and emptying the boiler.

The place in which the utenſils are kept ſhould likewiſe have a ſmall fire-place in it, in order that they may be well dried, in caſe they cannot be put out into the open air, which is always the beſt method, ſtone ſhelves being placed on the outſide for ſuch purpoſes. But ſtrips of wood placed in this direction ═══ inſtead of ſtone ſhelves would probably be much leſs expenſive, and the veſſels be found to dry much better upon them. The cream may be put into this room when the weather is cold, or juſt before it is churned, which is frequently found to be a good practice. In all the chimneys the greateſt care muſt be taken to prevent their ſmoking, as when that is the caſe, it is highly prejudicial to the milk and cream, as well as the utenſils of the dairy.

For the cheeſe-dairy, the milk-houſe ſhould be nearly on the ſame conſtruction with

* Very good coolers might probably be made from the beautiful black ſlate lately found on the eſtate of Lord Penrhyn, in Wales, as it may be raiſed to any thickneſs, and is capable of receiving a poliſh nearly equal to marble.

that which has been juſt deſcribed; all the milk being ſeldom made into cheeſe, there may be a neceſſity for coolers. Where the contrary is the caſe, it may be more convenient to have ſhelves for the milk veſſels, by which means they will always be at hand for carrying milk to the cheeſe-tubs, or copper when it is to be made warm.

The preſſing or ſcalding room may be made on the ſame plan as the churning-room deſcribed above; only it muſt be provided with a good cheeſe-preſs, which is much more handy than having it at a diſtance, as is often the caſe.

It would, perhaps, be ſtill more convenient to have one room large enough to ſerve for the ſeveral purpoſes of preſſing, ſcalding, and ſalting houſe. The ſalting-room ſhould be laid with flags, and made ſo as to readily carry off the water when it is waſhed out. It ſhould alſo be provided with a ſtrong table or ſhelf, for laying and turning the cheeſe upon, until they are in a proper condition for being put into the cheeſe-room. A convenient place ſhould likewiſe be made near to, or in, the houſe for containing ſmall ſand, for the purpoſe of ſcouring the dairy ſhelves and utenſils.

The cheeſe-room may be made over the dairy, but it is moſt commonly made above the cow-houſe or kitchen, the warmth of ſuch places being ſuppoſed to promote the ripening of the cheeſes *.

FARM-SHEDS.

These buildings are often extremely convenient and proper for various purpoſes of the farm. They are cheap and ſimple in their conſtruction, and erected without much labour. Places of this kind are moſt commonly made ſo as to lean to and reſt againſt the walls, or other parts of buildings, the eaſing or lower part being ſupported by a ſlight wall, poſts of wood, or ſtone pillars. Frequently, too, the whole of their roofs is ſuſtained by poſts or pillars. Theſe ſheds are of much utility for preſerving all the larger ſorts of farming implements from the effects of the weather, as well as for the protection of young animals of different kinds, ſuch as horſes, cattle, ſheep, &c. when they are turned looſe in the farm-yard. They might alſo be ſo contrived as to admit of ſtowing large quantities of different kinds of hay, when brought from the ſtack for the uſe of the cattle; by which it would be extremely ready and near at hand for foddering with; but not for depoſiting it in when firſt brought from the field, as in ſuch caſe it would be much leſs valuable. They may alſo be applied to various other uſes, which abundantly ſhews their importance in the economy of farm-buildings.

* Beatſon in Communications to the Board of Agriculture, vol. I.

STRAW-HOUSES.

WHERE the practice of ſtacking ſtraw prevails, theſe houſes are not ſo eſſentially neceſſary; it is, however, always adviſable to have ſome place or other in which a ſmall quantity can be depoſited for the daily ſupply of different animals, as by this means much time, as well as ſtraw, will be ſaved, and there will be much leſs dirt and litter about the yard.

ROOT-HOUSES.

WHERE a number of cows or cattle of any kind are fed on winter roots and vegetables, ſuch as carrots, turnips, potatoes, cabbages, &c. it is highly neceſſary to have houſes of this ſort, in which they may be placed and kept near at hand, when the ſeaſon is bad, for the daily ſupply of the cattle. But ſome vegetables, ſuch as cabbages, will not bear to be laid up in houſes in any conſiderable quantities, or for any conſiderable length of time, as they are apt to run quickly into the ſtate of fermentation, and become putrid.

POULTRY-HOUSES.

IN every caſe where any conſiderable number of poultry are kept, a place ſhould be provided for confining them in. This is particularly neceſſary for the farmer, as he may otherwiſe not only ſuſtain conſiderable injury by their depredations, but loſe much of the profit ariſing from them, by their being frequently killed, and their eggs loſt in the hedges and other places. As a free and uninterrupted circulation of air is highly neceſſary to the preſervation of the health and feeding of poultry, they ſhould not be cooped up in dark reſtricted hovels, but have a large ſuitable place conſtructed entirely for their uſe. It is not, perhaps, yet well aſcertained, whether different ſorts of poultry do better when kept ſeparate and diſtinct or not, though it would ſeem to be the caſe, as the economy and habits of each are different. Where ſufficient room can, therefore, be ſpared, it will be the propereſt method to have the entrances, as well as the reſting and breeding places of each ſort, diſtinct from the reſt; though the whole may be contrived ſo as to be under the ſame roof, and conſequently be fed from the ſame place, which will ſave time and trouble. If room can be had, there ſhould likewiſe be a yard proportioned to the number provided for the

whole ſtock, which ſhould be fenced in, in ſuch a way as to prevent their flying over, or getting through, and which ſhould communicate with the poultry-houſe, and be well ſupplied with water. If a pond or ſtream of water can be had, it is ſo much the better.

By theſe contrivances it will be found that poultry of all kinds may not only be bred and reared with great facility, but be kept more free from diſeaſe and accidents.

HOG-STIES.

In the conſtruction of theſe, little more is required than that they be made ſufficiently dry and warm, and that ſmall yards or areas be provided for the holding of troughs, and the reception of the food. It is probably the beſt and cheapeſt method to make them with ſhed-roofs, and neither very high nor wide; ſix or ſeven feet wide is quite ſufficient for a diviſion. There ought to be many of theſe diviſions, in order to ſuit different purpoſes, and contain different ſorts of hogs. Some ſhould be made for ſows when with the boar, others for brood hogs, and for farrowing, weaning the young pigs, and fattening in, &c.

As hogs are apt to ſlop over and ſpill a part of their food, by getting their feet into the troughs, there ſhould be a thin piece of board nailed on the back part of the troughs, ſo as to come forward, in a way to only juſt admit their heads; and they ſhould have a ſufficient number of diviſions, each riſing a little above the top of the trough. Many other ſorts of troughs may likewiſe be eaſily contrived for preventing the waſte of food, and it may be done by placing them in the diviſions of the yards.

It would be of great advantage to have conveyances for water, ſuch as open ſpouts for inſtance, paſſing through the ſties, in order that they may be frequently waſhed and kept clean, and that the hogs may drink when neceſſary.

In the conſtruction of theſe buildings, care ſhould likewiſe be taken that the animals be fed conveniently, and without going among them. Where a few ſwine are merely kept for family uſe, they may, if ſituation will admit, be fed with great eaſe and facility, by having holes, and troughs placed in the walls of the back kitchen of the farm-houſe. By this contrivance much ſtuff, which would otherwiſe probably be loſt, may be conveyed to them. Where a great number of hogs are conſtantly kept, it may be advantageous to have a furnace and copper near to the ſties for preparing their food.

COAL AND *WOOD HOUSES.*

FIRING being every-where an article of conſiderable expence, it is neceſſary that a proper and convenient place ſhould be provided for it. Houſes or yards for this purpoſe have moſt commonly been made without roofs or other coverings, but as coals are much injured by expoſure to the ſun and weather, they ought always to be well covered. They are more durable, however, when made wet before they are uſed. Where large quantities are conſumed, the large and ſmall coal ſhould be put ſeparately; and places made for putting cinders, and ſuch wood as has been broken up: if peat or wood only be uſed, theſe houſes ſhould be much larger and better ſecured in the roofs. Theſe places ſhould always be ſituated as conveniently as poſſible for the kitchen.

WORK-SHOPS.

WHERE the farm is extenſive, a place of this ſort is extremely uſeful and convenient, for making and repairing different kinds of tools, as well as for preſerving materials ready ſeaſoned and prepared for the purpoſe of conſtructing or mending ploughs, harrows, carts, wheels, and other implements of huſbandry. By this means the farmer is ſure of having his timber in proper condition, and always ready to his hand. Theſe ſhops ſhould always be provided with a good ſet of carpenter's tools, a bench to work upon, a lathe for turning different things, and a convenient grind-ſtone; and a blackſmith's ſhop may often be neceſſary on farms of very conſiderable extent.

It would likewiſe be of advantage to have a place for timber, and a ſaw-pit near at hand. The latter might be made under the ſame roof with the work-ſhop, if convenient. In the former all ſorts of wood or timber, and the broken or worn out implements ſhould be depoſited.

TOOL-HOUSES.

THE ſmaller ſorts of tools, ſuch as ſpades, forks, rakes, ſcythes, &c. &c. being exceedingly liable to be loſt, a place ſhould be provided for laying them in when not in uſe. Sacks, ropes, twine, nails, and old iron, may alſo be laid up with them. For this purpoſe the place need not be large, but it ſhould be dry and free from damps. Of this room, the maſter of the farm ſhould always keep the key, in order that he may readily know where to find ſuch tools, or other articles, as he may want.

STORE-ROOMS.

The farmer, in particular ſituations, frequently finds it neceſſary to ſtore up ſome of the produce of his grain; ſuch, for inſtance, as meal, in order to get a better price for it; he ſhould, therefore, be provided with a ſuitable ſtore or meal room. Theſe rooms ſhould be as dry as poſſible, and perfectly ſecure from vermin. An upper floor is probably the beſt for ſuch purpoſes, provided the articles can be conveniently and eaſily conveyed to it. They ought to be furniſhed with ſtrong well-made cheſts, for holding the meal, or other articles, that may be put into them. If meal, it ſhould be well rammed or preſſed down, by means of a proper beetle, in order to make it keep ſweet and well.

FARM SERVANTS'-ROOMS.

Where farms are extenſive, and, of courſe, many ſervants required, eſpecially if they be unmarried, proper and convenient accommodations for ſleeping, and, where they find their own proviſions, for preparing and dreſſing them in, are not only neceſſary, but highly advantageous both to the farmers and the men; they ſave much time, which would otherwiſe be loſt, in going to their meals, and keep them together ſober, ſteady, and ready for their buſineſs. Beſides, the men in this way are much more comfortable, and live conſiderably cheaper, than when it is the cuſtom to go to public-houſes, or other ſuch places, for their meals, which is too much the caſe in many of the more ſouthern diſtricts of the kingdom, by which their manners often become depraved, and their conſtitutions enfeebled, by the great uſe of ſpirits, and other intoxicating liquors.

Theſe inconveniences are, however, the moſt effectually provided againſt by ſuch ſervants being provided for, where it can be done, from the tables of their maſters. Where this laſt method is followed, the eating-rooms ſhould be ſo ſituated that they may be overlooked with facility; but the lodging-rooms in both caſes are the ſafeſt, perhaps, when made in a building quite detached and diſtinct from the other houſes and offices, perſons of this deſcription being often extremely negligent of their fires, candles, &c.

Whatever ſituation may be fixed upon for theſe conveniences, the ground floors ſhould always be of ſtone or brick, and the upper ones made with plaſter, as in ſome of the midland counties; or brick, which is eaſily and frequently laid. In con-

ſtructing theſe floors, the joiſts are laid in the common method, then a ſtrong ſort of reed is faſtened down to them, upon which the plaſter is placed. If with brick, the joiſts are laid twelve inches apart, and the bricks made to reach from joiſt to joiſt, and joined ſides and ends with well-wrought mortar; it might alſo be adviſable to have the ſtairs made of the ſame materials. In order to ſave this laſt material, there is, however, ſometimes a ſlight coat of common lime laid on firſt, ſo as juſt to fill up the inequalities; the plaſter being afterwards ſpread about two inches thick upon this, in doing which great expedition muſt be uſed. Where reeds cannot be procured, ſmall thin laths may be employed in their ſtead; theſe are, however, more expenſive. In the diſtricts where this mode of conſtructing floors is practiſed, the plaſter is prepared and ſold at the kilns for about ſix pence the buſhel; and the expence of putting it on, if burnt and prepared, is about five pence the ſquare yard.

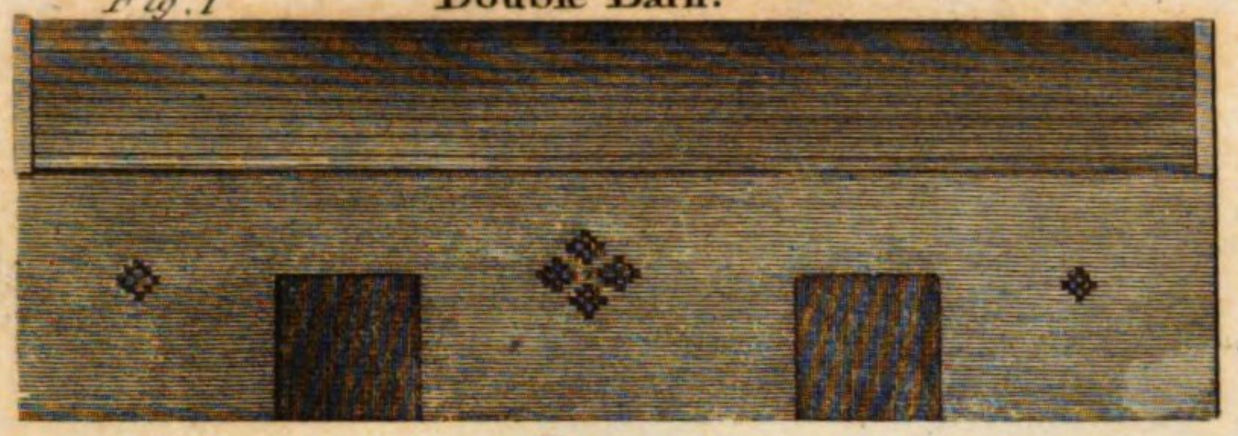
The places for the ſleeping of ſervants may be ſo contrived as that ſeveral perſons may be accommodated in a narrow compaſs; this is done by the beds being fixed and placed in double tires one above another, four beds in this way only occupying the room of two on the uſual plan. The approach to the upper beds may be rendered ſufficiently eaſy and convenient, by having proper ſteps or ſtairs; and may be made either on the ſame ſide with the other beds, or on the contrary, as from ſituation, and other circumſtances, is the moſt ſuitable. It will however be proper, and even highly neceſſary, where ſo many perſons ſleep in ſo ſmall a compaſs, that the windows be pretty large, and ſo contrived as to readily admit of a free circulation of pure air*.

Beſides the buildings and accommodations, which have been already deſcribed, there are ſeveral others that are frequently neceſſary both for the convenience of the houſe, and the feeding and management of different kinds of ſtock.

Thoſe of the firſt kind are chiefly places for brewing, baking, waſhing, ſlaughtering animals in, &c. and for keeping pigeons, bees, and other ſtock of a ſimilar nature. The ſituation and conſtruction of many of theſe are, however, not only ſo ſimple and well underſtood, but muſt ſo frequently depend on particular circumſtances, that it is unneceſſary to give detailed accounts of them.

* Though this method may ſave much expence, as well as room, it will certainly be diſadvantageous in point of health; for it muſt be obvious to every one the leaſt converſant with the nature of airs and reſpiration, that the air of ſuch ſmall cloſe rooms muſt quickly be diſoxygenated and rendered noxious by the breathing, perſpiration, and heat, of ſo many perſons, and that unleſs ſeaſonable ſupplies of freſh air be admitted, dangerous conſequences may enſue.

Fig. 1 Double Barn.



Improved Barn. Fig. 3.

Fig. 2.

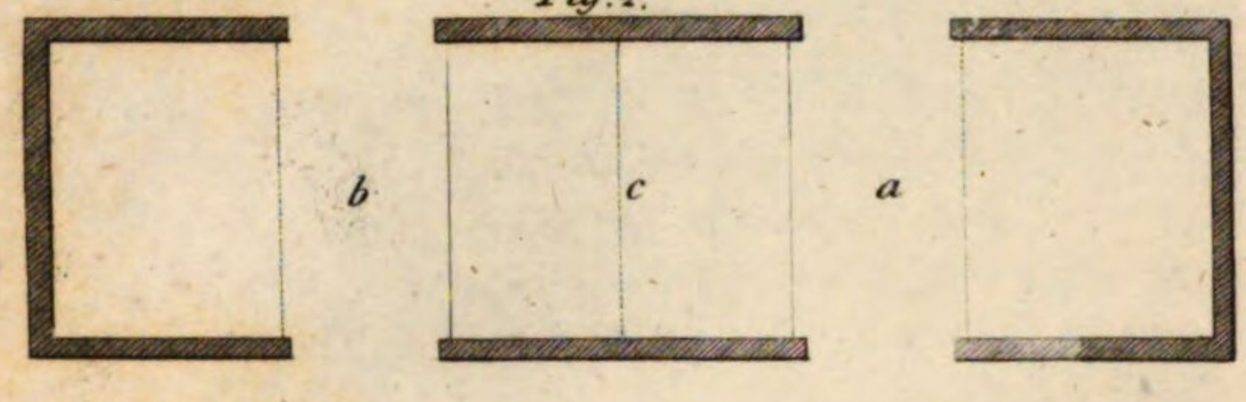
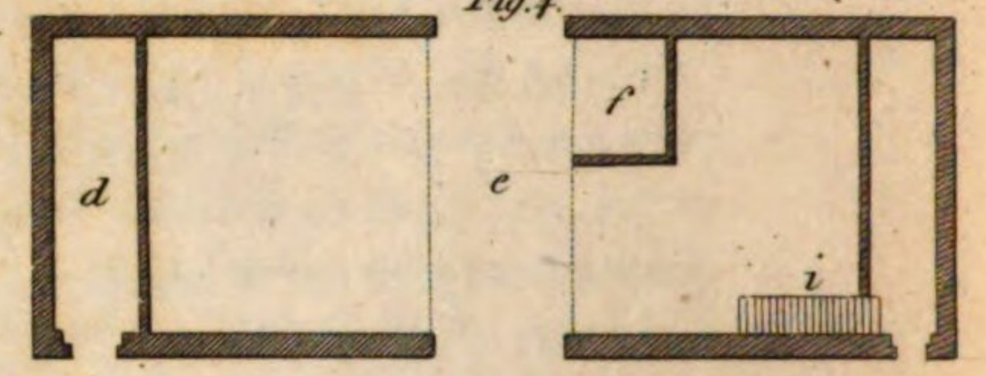


Fig. 4.



Open Barn. Fig. 5.

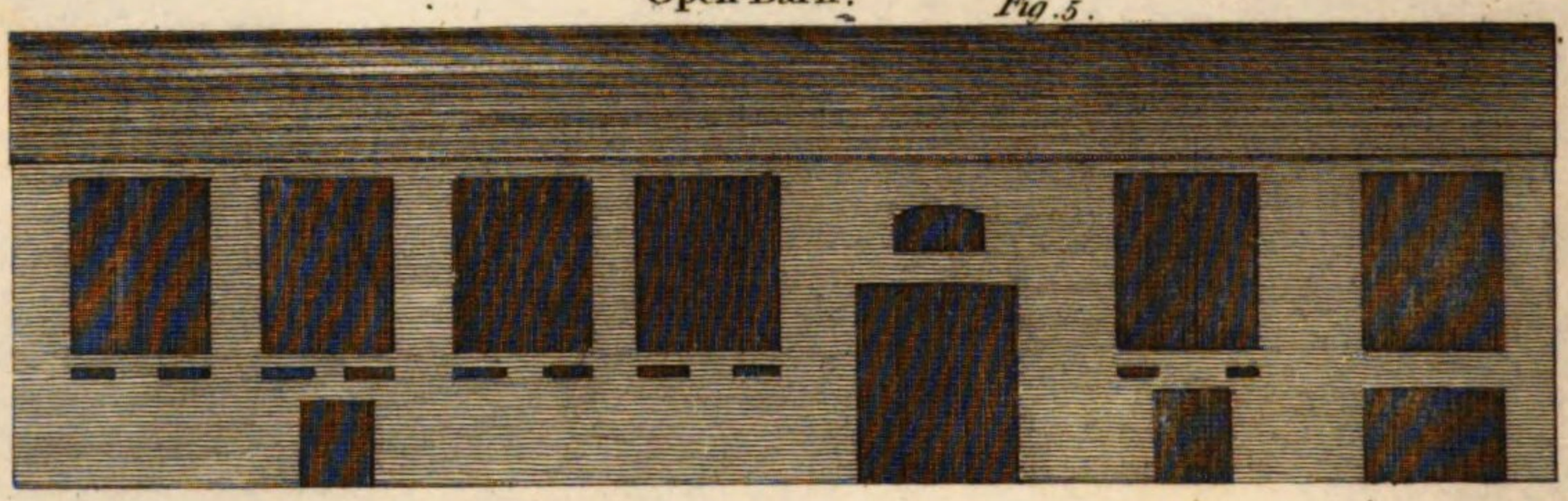


Fig. 6.

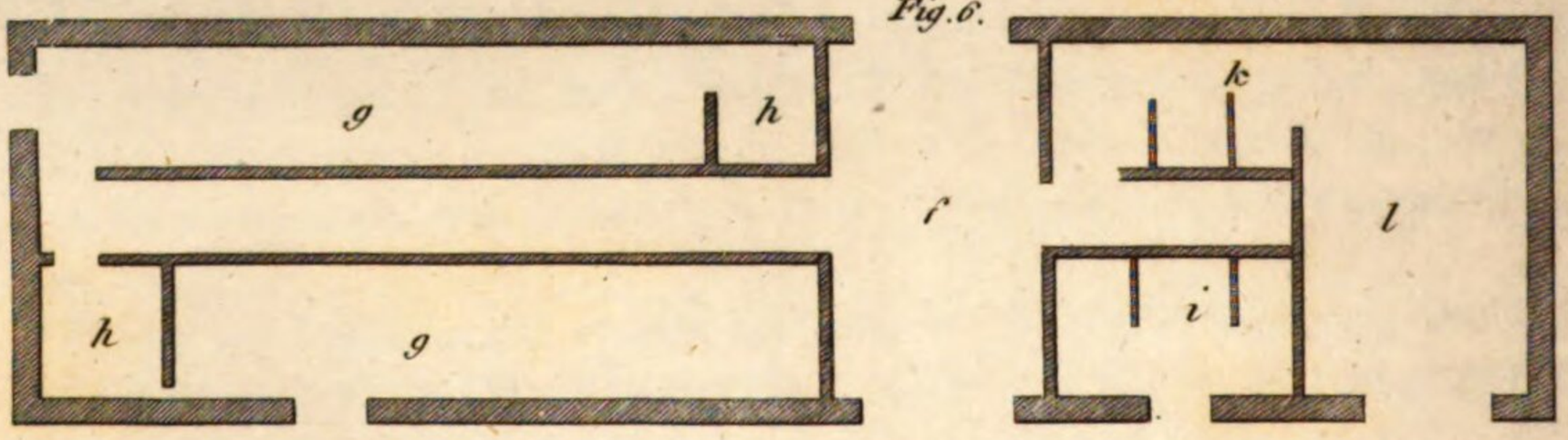


Fig. 7. Barn with Granary & Threshing Machine.

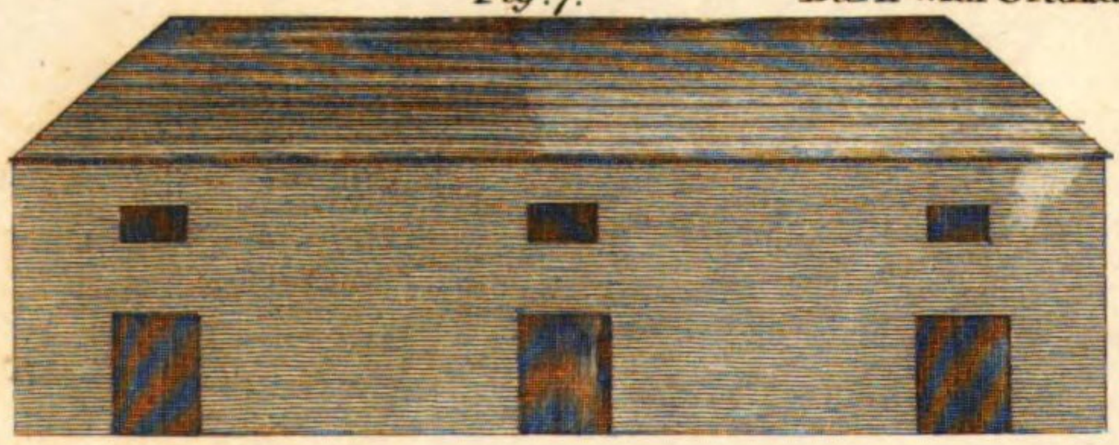


Fig. 8.

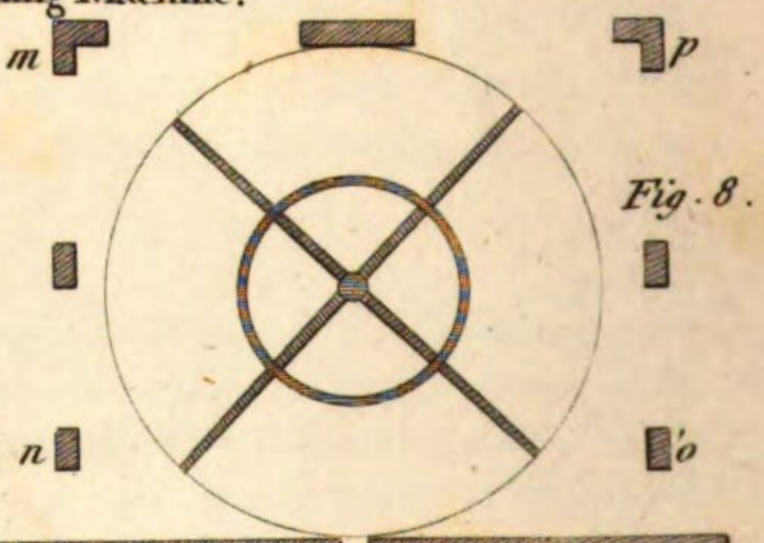
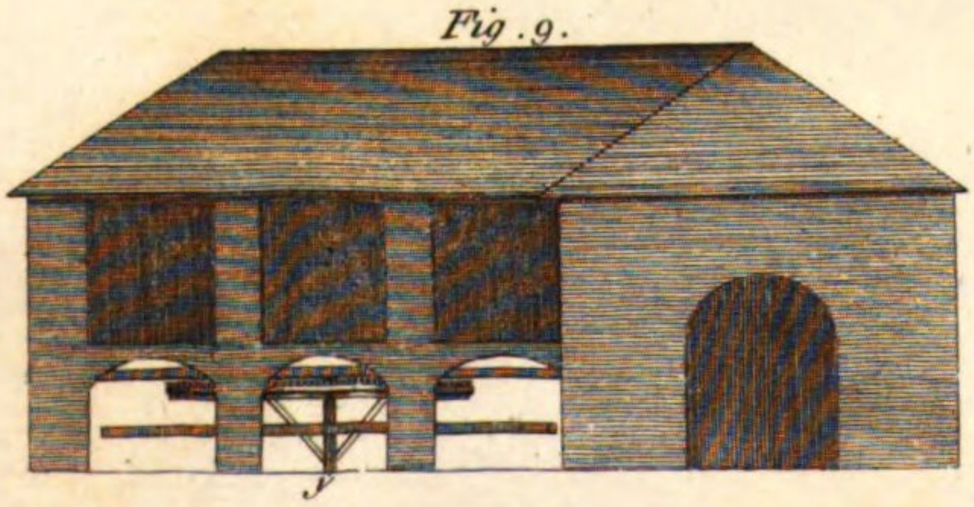


Fig. 9.



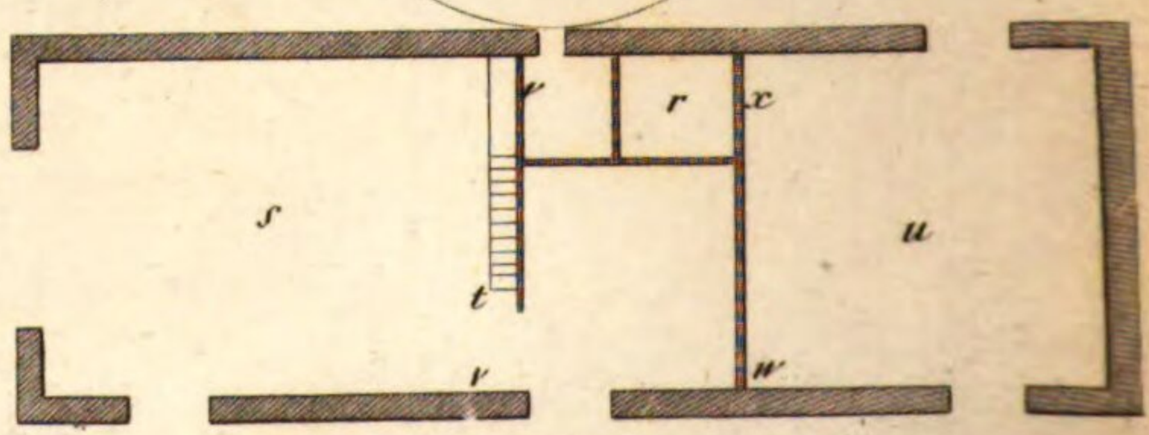


PLATE XVIII.

Barns.

[*To face Page* 64.]

AT *Fig.* 1. is repreſented the plan and elevation of a *Double Barn*. *Fig.* 2. The ground plan, *a* and *b* the thraſhing-floors; *c* a dotted line, ſometimes built ſo as to form a partition.

Fig. 3. Is the plan and elevation of an *Improved Barn*. *Fig.* 4. The ground plan: *e* the thraſhing-floor; *f* bin or room for thraſhed grain; *i* ſtairs leading to granary, with place under for roots, &c.; *d* place for tools or other purpoſes.

Fig. 5. Shows the plan and elevation of a large *Open Barn*. *Fig.* 6. The ground plan: *f* the thraſhing-floor placed towards one end; *g g* cow-houſes containing eleven ſtalls on each ſide; *h h* calf pens with ſparred floors; *i* a double ſtall, with two ſingle ones for four cows; *k* two ſtalls; *l* a work-ſhop, root-houſe, or place for keeping implements. The corn in the ſtraw is kept above. The large openings in this barn ſave much expenſe in building.

Fig. 7. Front and end elevation, with plan of a barn, and thraſhing-machine for a three-horſe power. It is contrived to winnow and clean the grain while thraſhing, and may be made to cut chaff, ſplit beans, hoiſt the produce up to the granary, and execute various other ſorts of work, as grinding, pumping, &c. *m n o p*, *Fig.* 8. is the ſquare for the horſe-path, the dotted circle the path. *y*, *Fig.* 9. is the upright ſhaft in its centre; and *z* a granary or ſtore-room for ſtraw, hay, &c. over it.

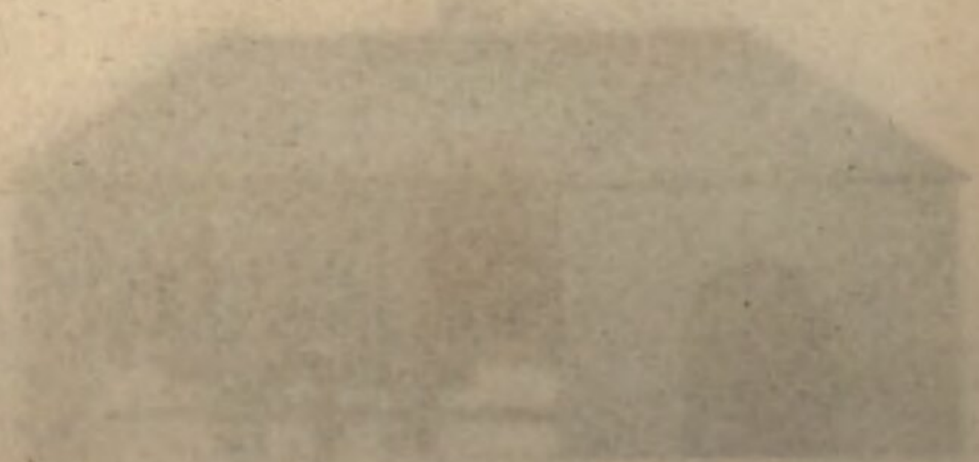
At *v*, *fig* 8. may be made a communication to afford eaſy acceſs to the mill when corn is lodged there for thraſhing. The mill-head is erected on a floor about ſeven or eight feet above the ground floor, to give room for the fanners or winnowing machine below. It is extended the whole breadth of the barn, and about 15 feet or more towards *s* from the back part of the mill at *q* by which, and being properly partitioned below, a very neceſſary and uſeful diviſion, *z*, may be got for containing the clean corn till drawn up to the granary: the door of this place may be kept locked for ſafety. The ſpace *r* contains the chaff blown from the fanners a door by through the partition to render the communication more eaſy and expeditious from the part *s* where the unthraſhed corn is laid: a door might alſo be made in the partition at *w*, but this is not ſo neceſſary, as may be ſeen where the ſtraw goes, by ſtanding on the thraſhing-mill floor, to which there ſhould be ſteps up at *t*. It may be made alſo to rake away the ſtraw, and to throw it down to the part *t*, which will ſave a perſon raking from the mill. The expenſe if, made to clean the corn and rake away the ſtraw only, which in general is ſufficient, will be about 50*l*. excluſive of flooring, &c. If made to hoiſt up the corn, to ſplit peas or beans, and cut ſtraw, from ſix to ten pounds more for each of theſe operations.

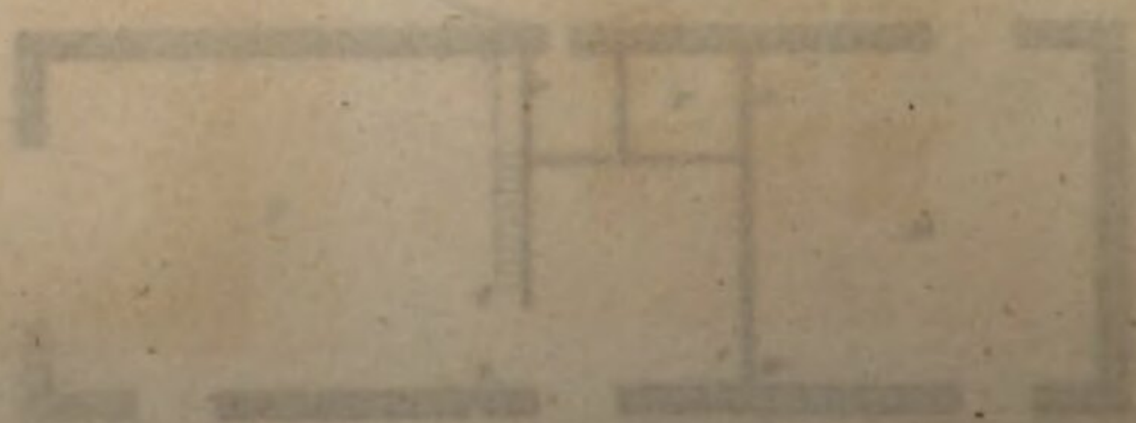
Theſe plans are recommended by Mr. Beatſon, as very uſeful where barns and thraſhing-machines are neceſſary.

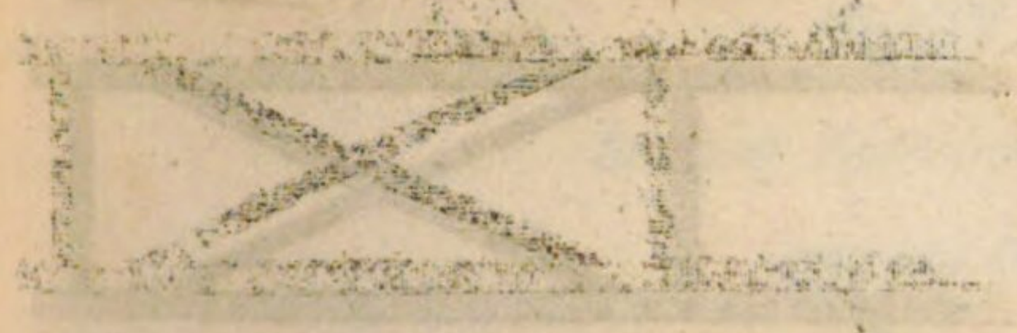
PLATE XVIII.

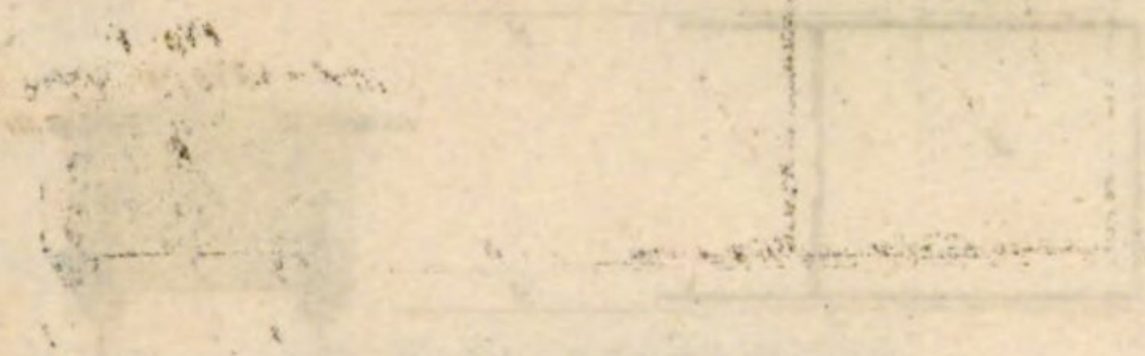
Barns.

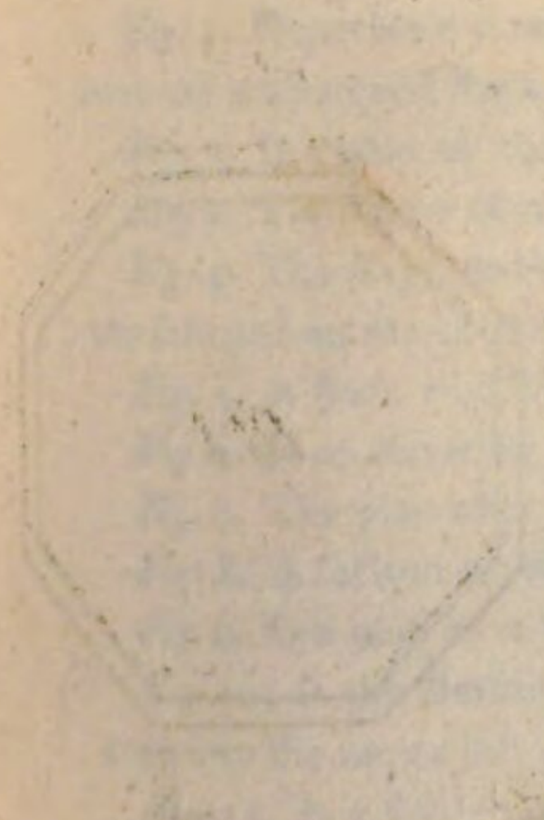
[To face Page 64.]











STACKING APPARATUS & GRANARY.

Fig. 1.

Fig. 5.

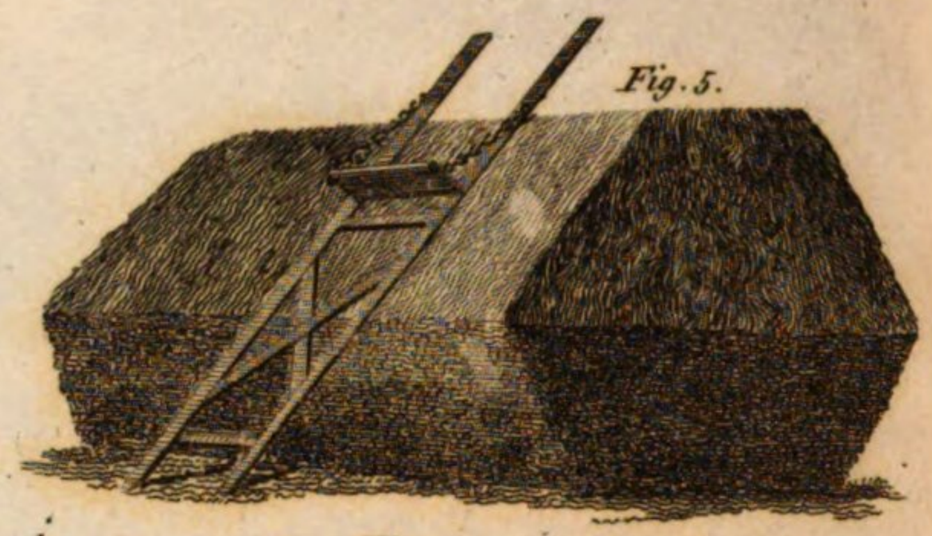


Fig. 2.

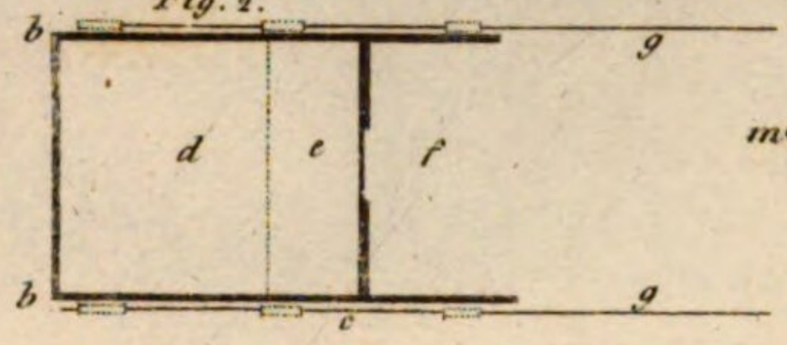


Fig. 4.

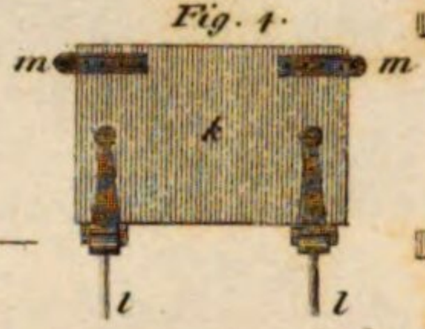


Fig. 3.

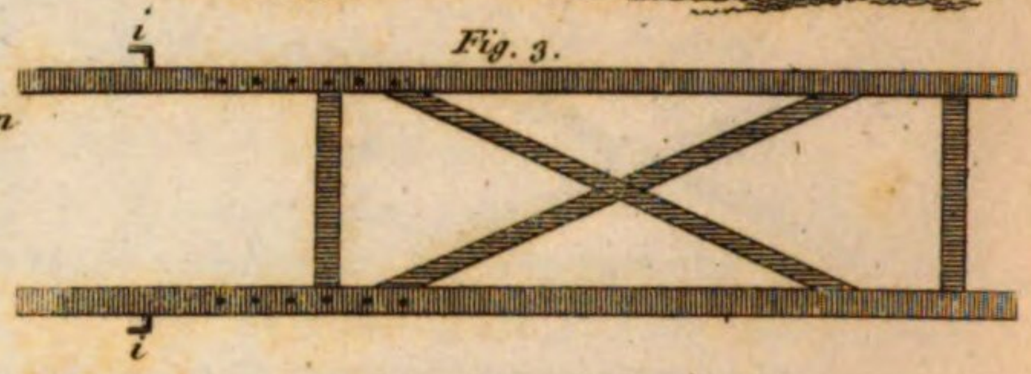


Fig. 6.

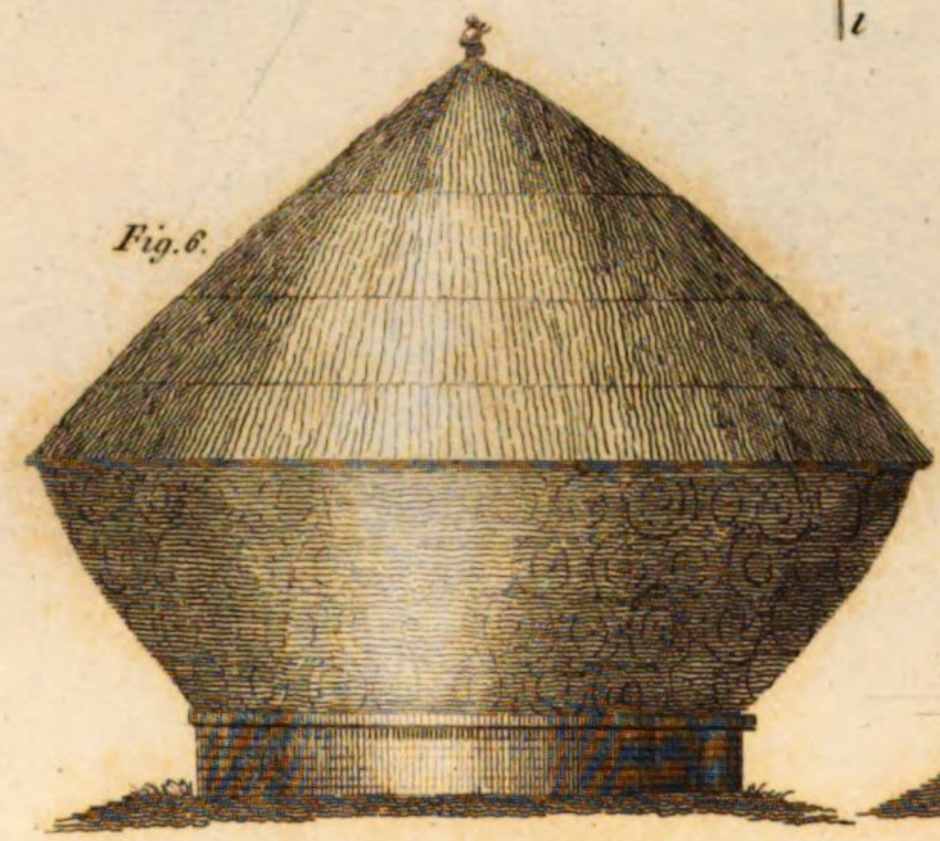


Fig. 7.

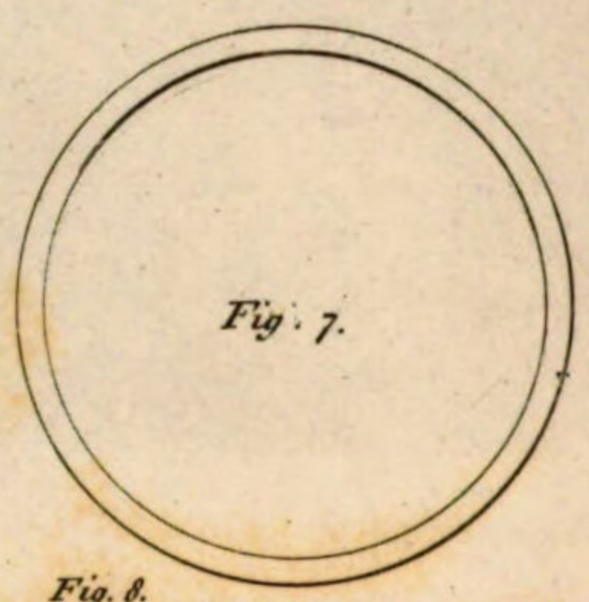


Fig. 9.

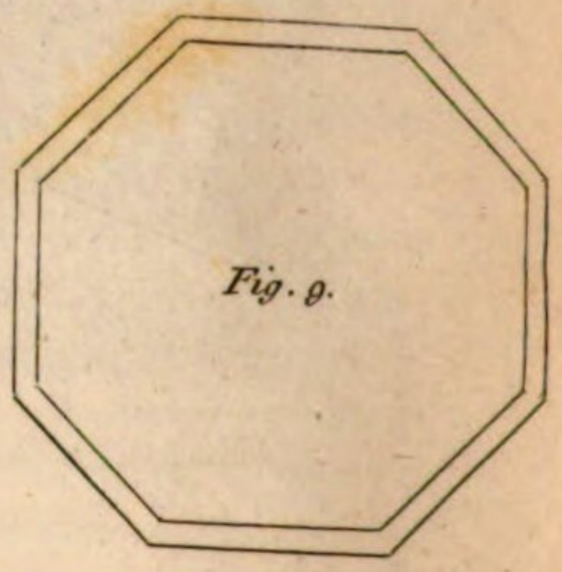


Fig. 8.

Fig. 12.

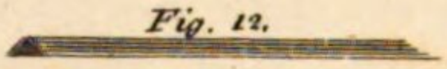


Fig. 10.

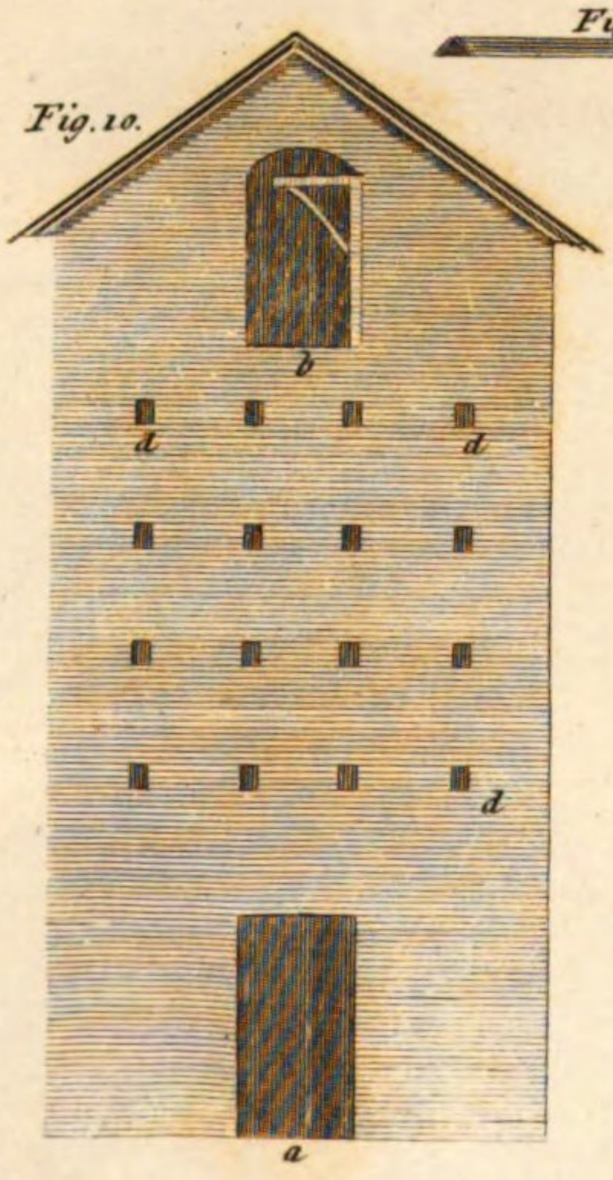


Fig. 11.

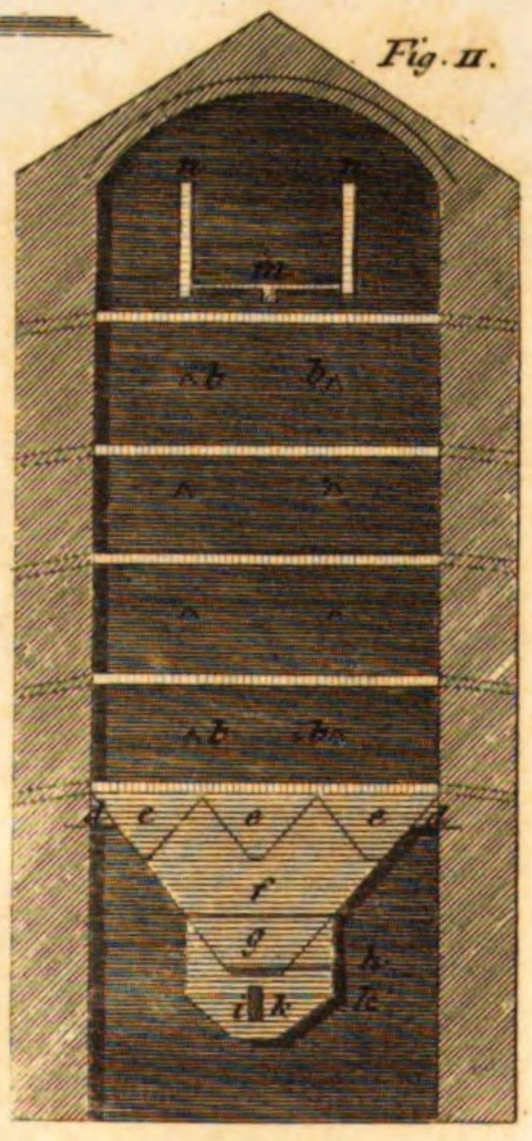


Fig. 13.

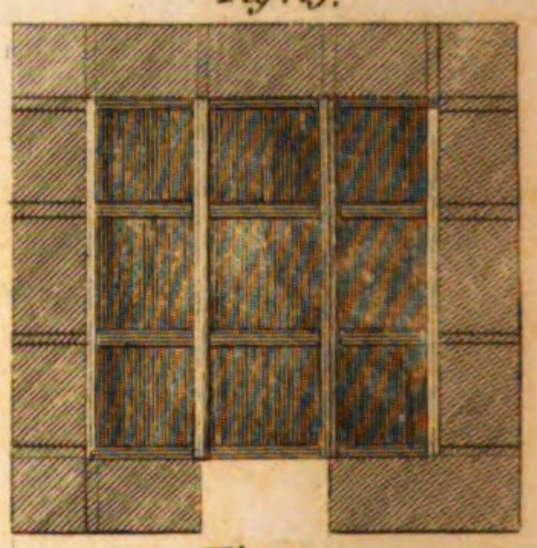


Fig. 14.

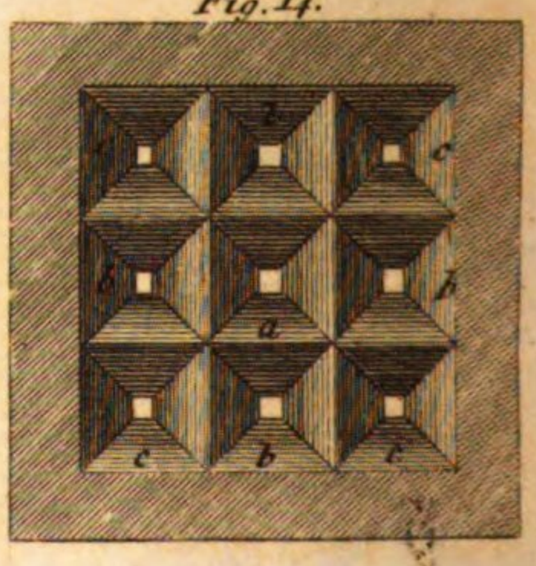


PLATE XIX.

Stacking Apparatus and Granary.

[*To face Page* 64.]

Fig. 1. Repreſents a moveable ſhed, which, after the work of the day, is drawn forward over the unthatched ſtack.

Fig. 2. Is a plan of the ſame contrivance.

Fig. 3. The frame of a moveable ſtage. *i. i*, iron hooks.

Fig. 4. The ſtage, to be fixed, by means of the pins *l. l*, into the holes of the frame. Chains are faſtened on the plates *m. m*, and from thence put over the hooks *i. i*.

Fig. 5. A ſtack with the moveable ſtage erected againſt it.

Fig. 6. Is an elevation of a ſtack on its ſtand.

Fig. 7. The plan of a round ſtand for corn ſtacks.

Fig. 8. A ſection of the ſame ſtand.

Fig. 9. Is a plan of a ſtand for an octagon ſtack.

Fig. 10. Is the elevation of an improved granary. *a* the door; *b* the crane for lifting the corn into the upper loft; *d d d* air-holes, to ventilate the different lofts.

Fig. 11. Is a ſection of the ſame.

Fig. 12. Shows the plan of the floor, in which the middle is higher than the ſides.

Fig. 13. Repreſents the method of conſtructing the tops of the bins, in which the corn is put.

Fig. 14. The bottoms of the bins, formed in the ſame manner as the hoppers of a common mill.

HORSE STALLS & SINGLE CATTLE SHEDS.

Fig. 2.

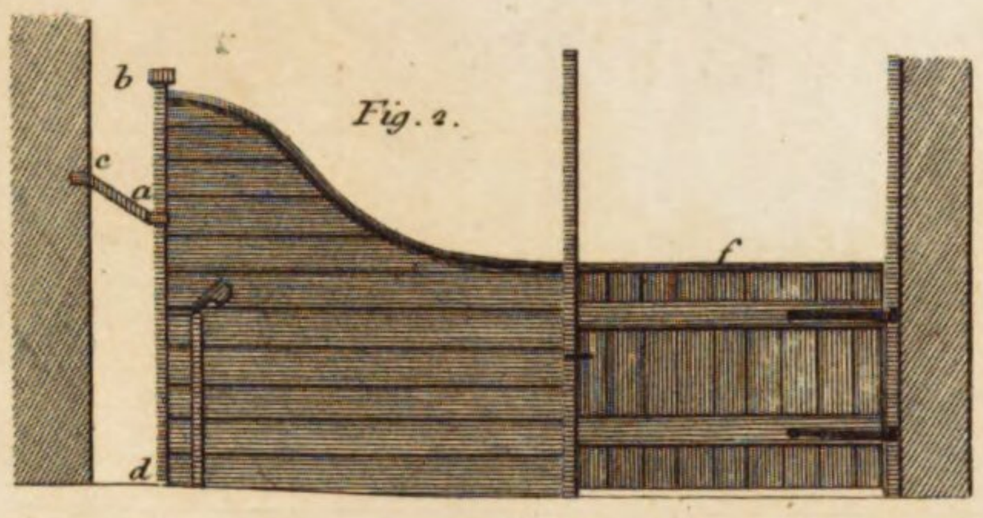


Fig. 3.

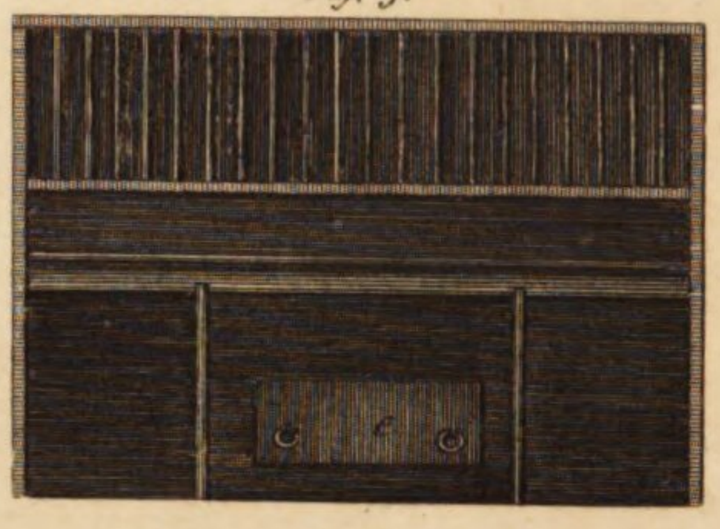


Fig. 7.

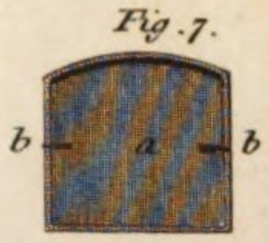


Fig. 8.

Fig. 1.

Fig. 4.

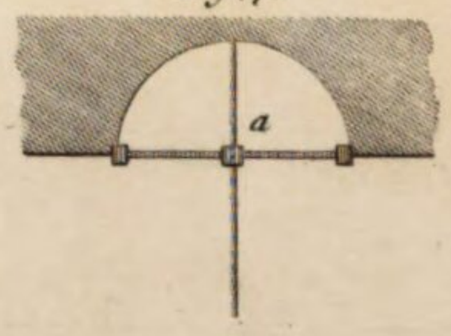


Fig. 5.

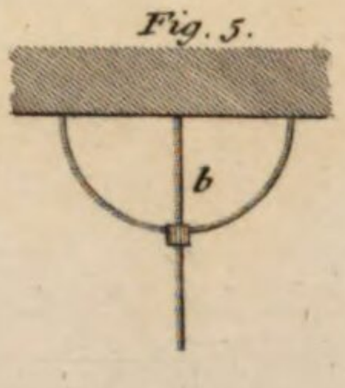


Fig. 6.

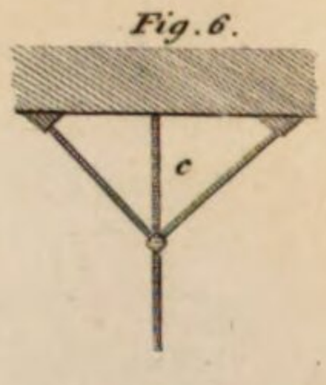


Fig. 13

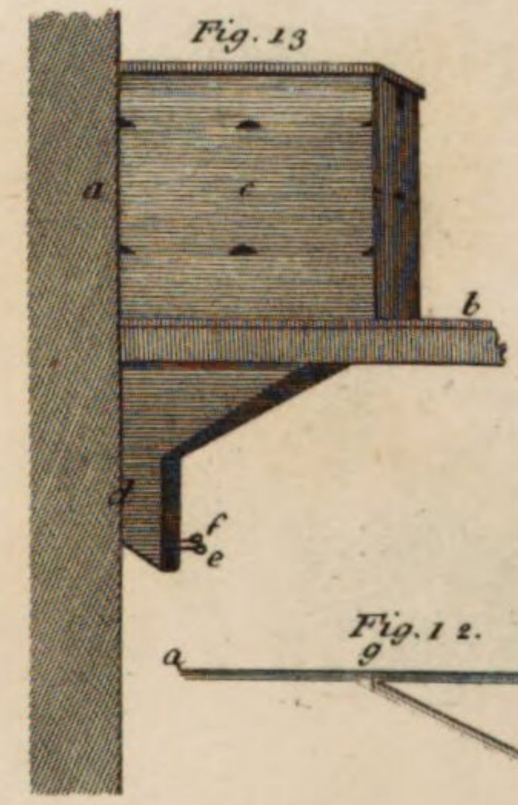


Fig. 9.

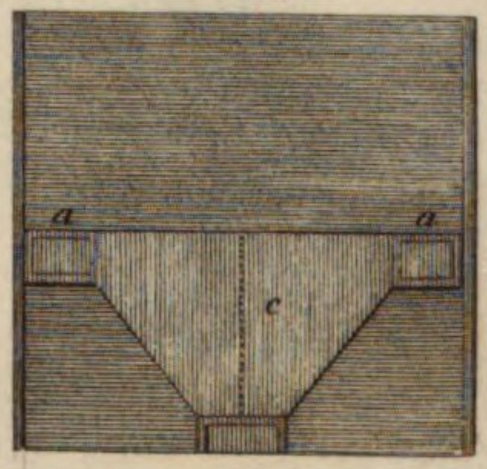


Fig. 10.

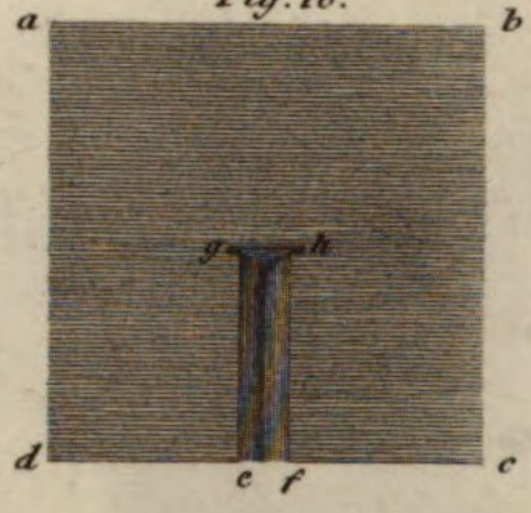


Fig. 12.

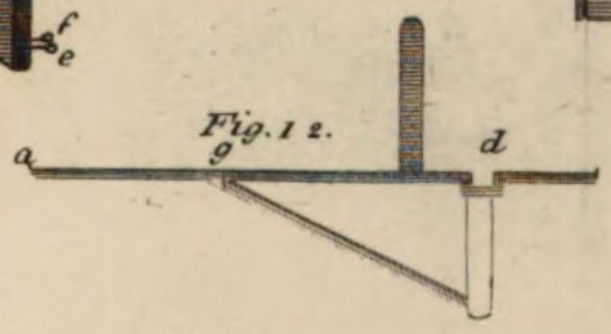


Fig. 11.

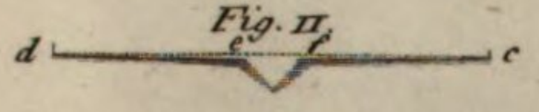


Fig. 14.

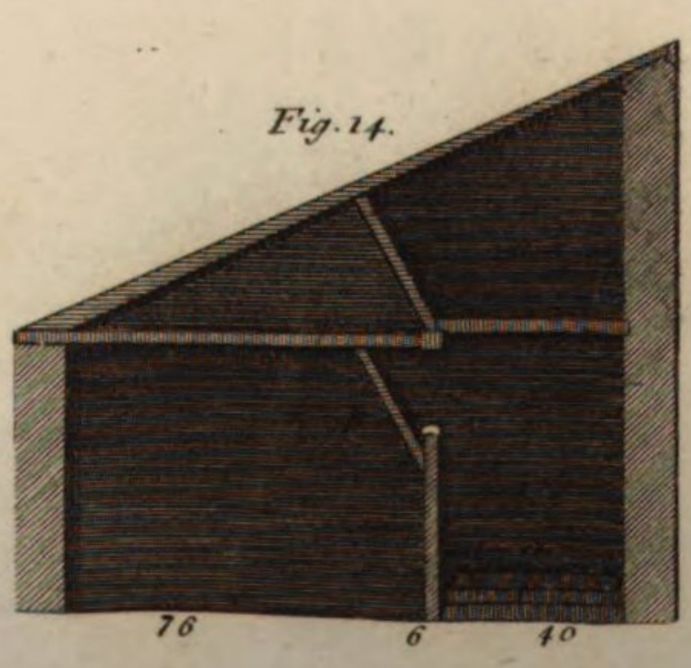


Fig 15

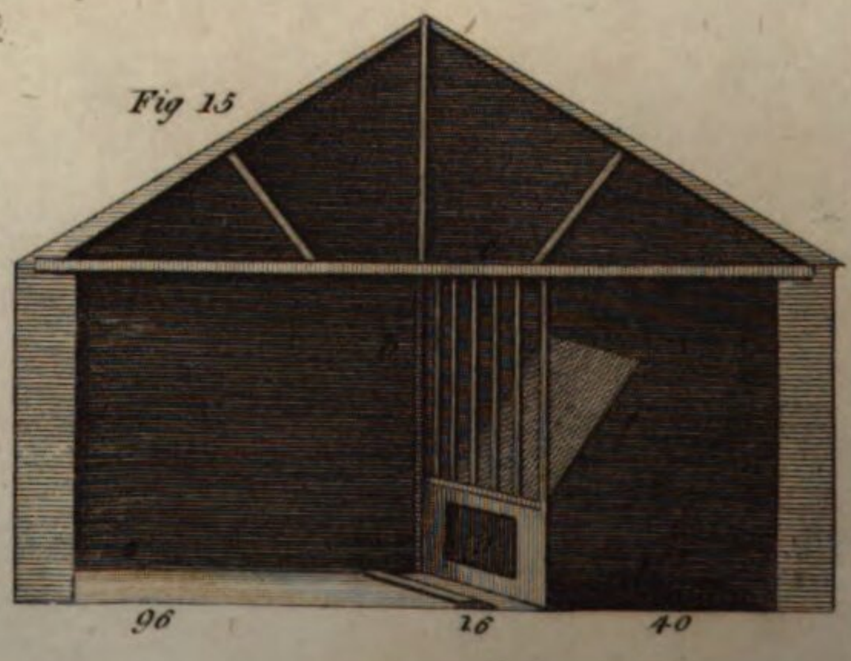


PLATE XX.

Horſe Stalls and Single Cattle Sheds.

[*To face Page* 64.]

Fig. 1. Repreſents the common method of placing the racks and mangers in ſtables: *a* the poſitions of the rack; *b* that of the manger.

Fig. 2. Shows the improved poſition of racks 14 inches from wall; *a b* ſpars of rack; *a c* bottom of rack, ſparred for ſeeds to fall down to *d*, whence taken out by drawer *e* in fig. 3; *f* a door ſometimes made uſe of in ſtables.

Fig. 3. Is a front view of rack and ſeed box.

Fig. 4. Repreſents racks placed in niches in the wall ſo as to ſerve two ſtalls; *a* diviſion betwixt.

Fig. 5. Shows the ſame placed in the angles without niches; *b* diviſion betwixt.

Fig. 6. Exhibits the form of racks for the angles; *c* the diviſion.

Fig. 7. and 8. Show the manner of fixing the windows or ſhutters: *a* the front view of window with ſhutter fitted to it, being ſuſpended on iron pins in the middle at *b b*, on which it turns; *b*, fig. 8. is a ſide view, ſhowing poſition of ſhutter, *c d*, when opened a little.

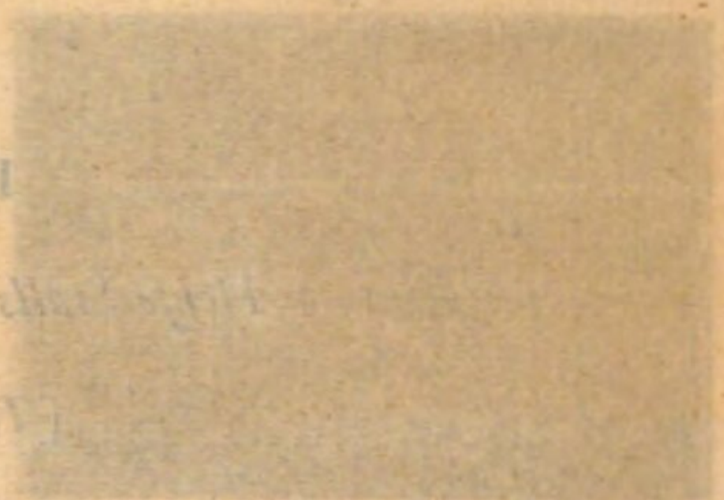
Fig. 9. Repreſents a ſort of hopper or contrivance, where neither racks nor mangers are employed; it is 14 inches wide at bottom, and ſparred for the ſeed to drop into a drawer; *a a* boxes in the corners for corn; *b b* hay-manger divided by the dotted line *c*.

Fig. 10. Is a ſtall: *a b c d* the ground-plan; *a b* inner end to which the horſe is tied. It is paved on a level from *a* to *d* and from *b* to *c*, a ſmall ſeven-inch drain being left in the middle, as *e f h g*, made to within 3 feet of inner end, forming an angle at bottom, as ſhown in croſs ſection, fig. 11; depth at *g h* 3 inches, ſloping to *d* in longitudinal ſection, fig. 12. into which the ſtall-drains paſs; theſe being covered by two-inch plank perforated with holes ſecured by hinges or two iron pins, *g h*, fig. 10. The main drain may be made at *d* in the end of the ſtall, or otherwiſe as convenient.

At fig. 13. is ſhown a corn-bin: *a* the wall of ſtable; *b* the floor of room; *c* corn-bin with air-ſpouts; *d* a ſpout below the bin in ſtable; *e* a plate iron ſlider at its bottom with lock if neceſſary; *f* another ſlider to regulate the feed between it and *e*, the feeds being this way eaſily taken out.

Fig. 14. Repreſents a *ſingle cattle ſhed: a* the paſſage before cattle; *b* rack for hay or ſtraw; *c* a room for fodder, litter, &c.

Fig. 15. Shows another method of conſtruction in theſe ſheds uſed in Shropſhire: *d* the paſſage; *e* perpendicular rack, with thin deals behind in poſition, *f* for hay: under *f* is a ſquare hole *g*, oppoſite each ſtall, for foddering the cattle through from paſſage *d*. Theſe were deſigned by Mr. Beatſon, and are cheap and convenient.



DOUBLE CATTLE SHEDS.

Fig. 1.

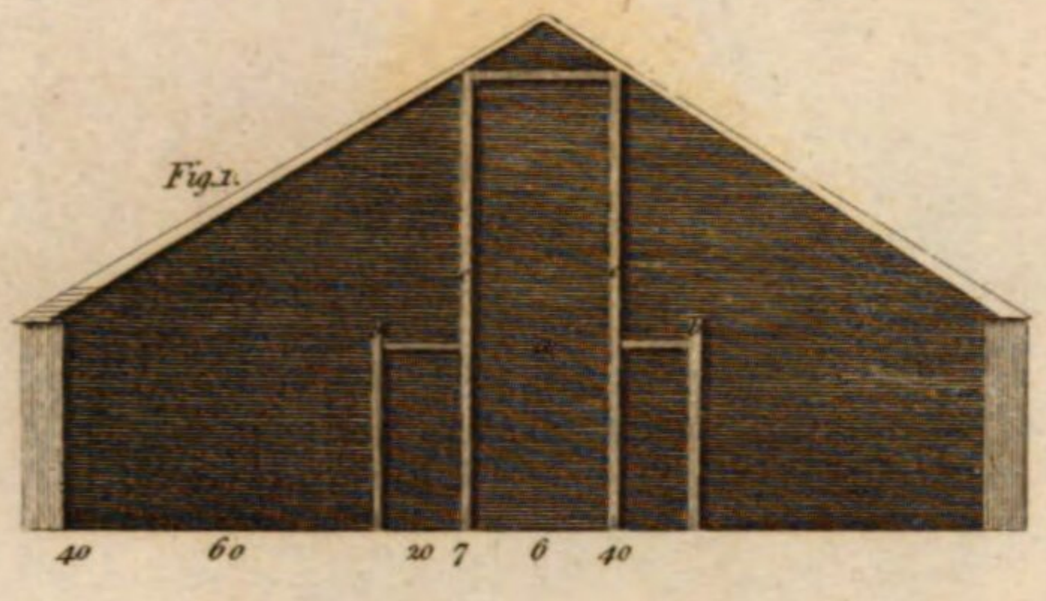


Fig. 2.

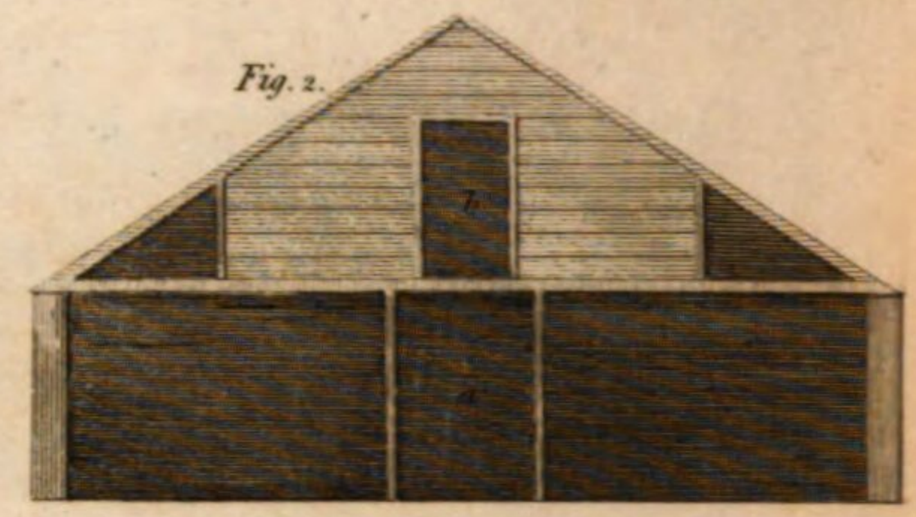


Fig. 4.

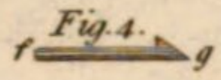


Fig. 3.

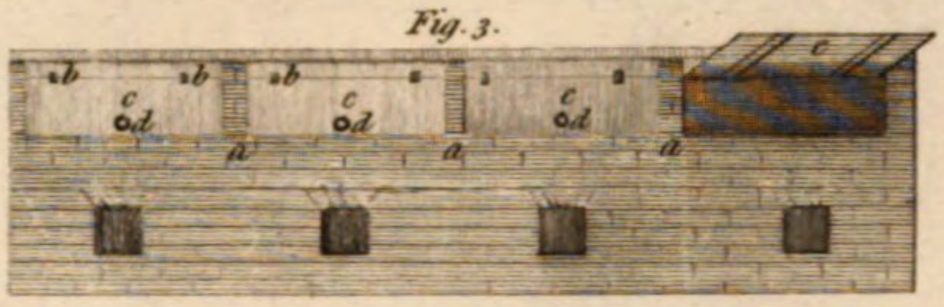


Fig. 8.

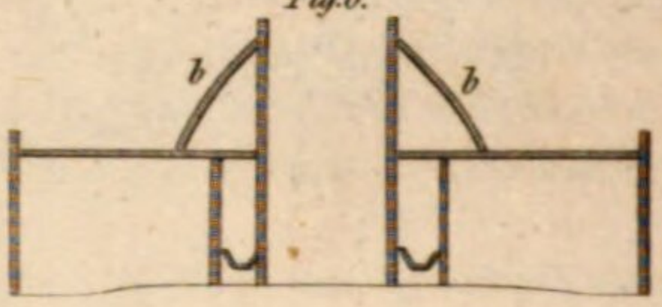


Fig. 7.

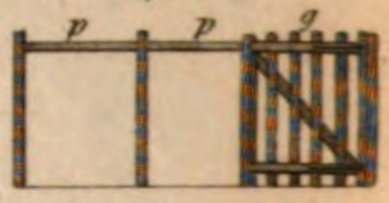


Fig. 6.

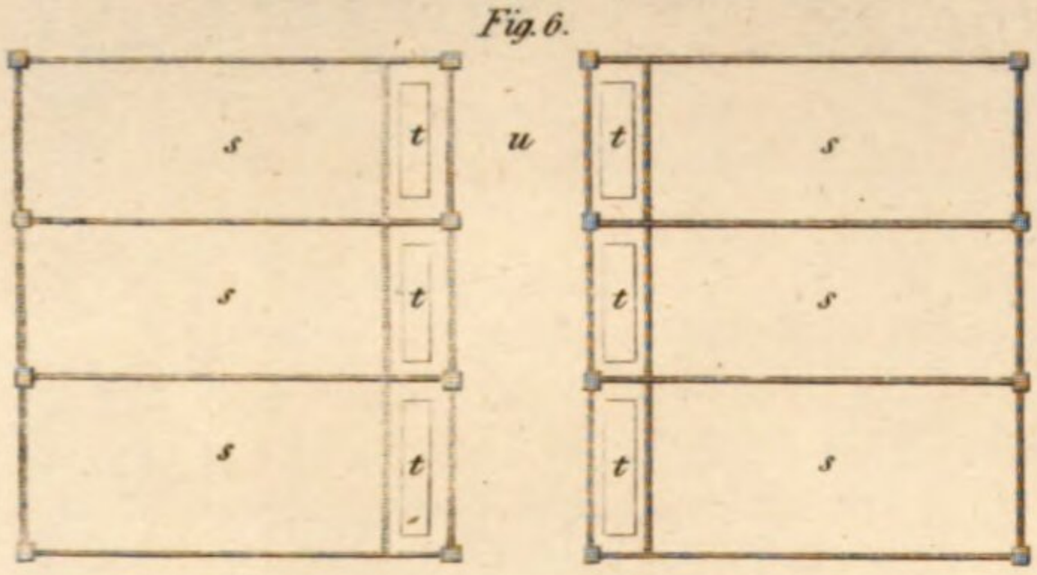


Fig. 11.

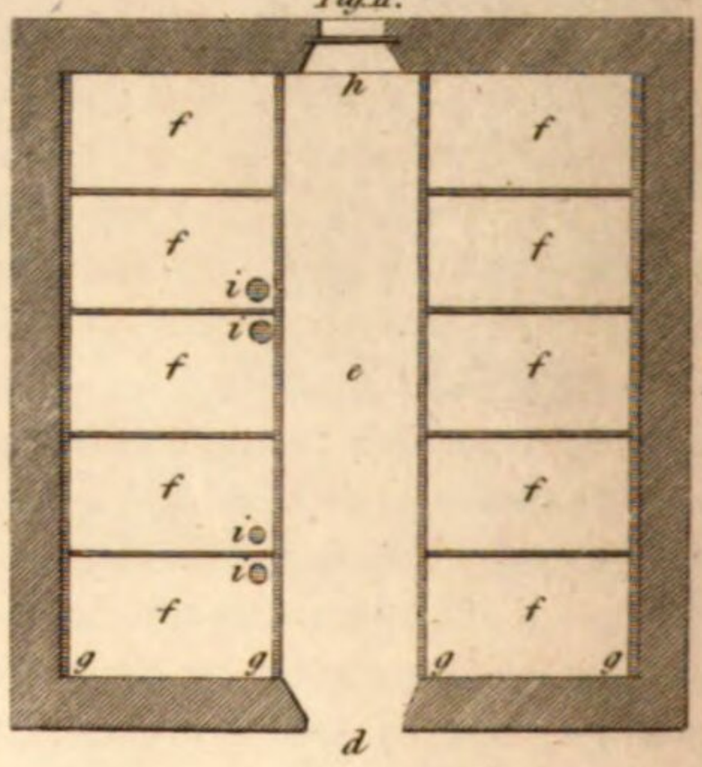


Fig. 5.

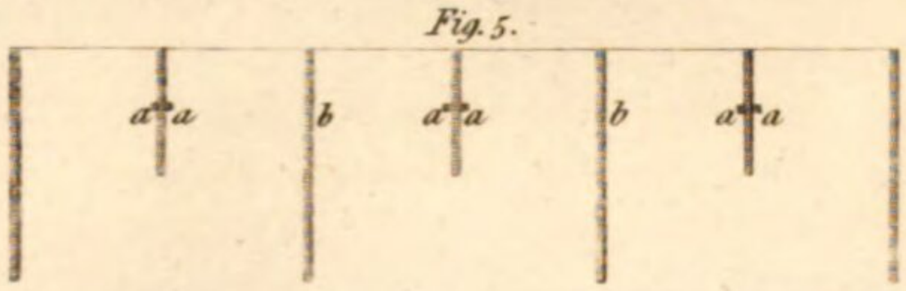


Fig. 9.

Fig. 10.

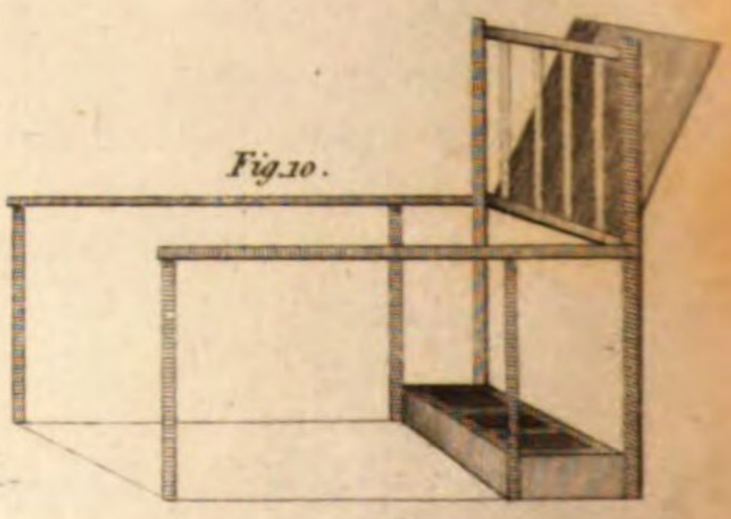


Fig. 11.

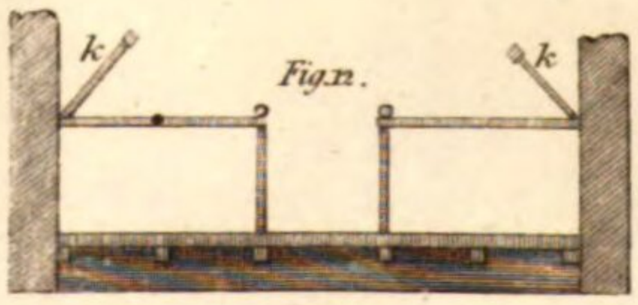


PLATE XXI.

Double Cattle Sheds.

[*To face Page* 64.]

Fig. 1. Repreſents a *double ſhed* for cattle, in which *a* is the paſſage before the heads; *b b* ſtakes to which they are tied up; *c c* poſts or pillars for the purpoſe of ſupporting the roof. It may be an advantage to have racks when neceſſary, as in fig. 15, Pl. XX.

Fig. 2. Repreſents another form of double ſhed, in which *a* is the gangway before the cattle; *b* a room over which may ſerve many different purpoſes.

Fig. 3. An internal part of the ſheds for containing the fodder. In ſingle ſheds it is contrived ſo as to admit its being put in from the cart by having covers that open on hinges: the roof being ſupported on pillars *a a a*, three or four feet in height, placed on the wall at the diſtance of eight or ten feet from each other: *b b b* the hinges; *c c c* the covers; *d d d* rings for pulling them open by; *e* one of the covers open, and held by the catch *f g*, fig. 4. which is moveable on a ſmall pin, the heavy end, *f*, within the fixed boards, and the other, *g*, without, to catch in a hole made for the uſe in the cover when opened.

Fig. 5. Repreſents plans of ſtalls with ſlight diviſions betwixt them, where cattle are bound in pairs, as in many of the northern diſtricts: *a a a* the ſtakes to which they are tied; *b b b* the partitions of the ſtandings.

Fig. 6. Plans of narrow ſtalls, where the cattle are not bound, but confined ſeparately in them. *s s s* the ſtalls; *u* the paſſage betwixt; *t t t* the troughs from which the cattle feed.

Fig. 7. The elevation of the hind part of theſe ſtalls: *p p* rails to lift out at the ends; *g* a little hatch or gate ſometimes made uſe of.

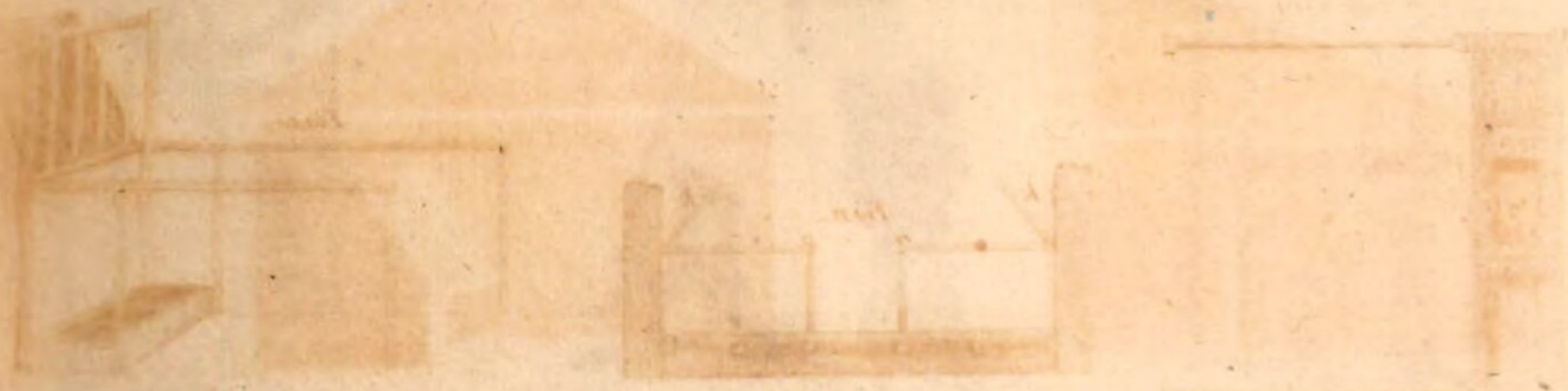
Fig. 8. Is a ſection of theſe ſtalls: *b b* ſhort rails or braces to keep the cattle from touching with their horns.

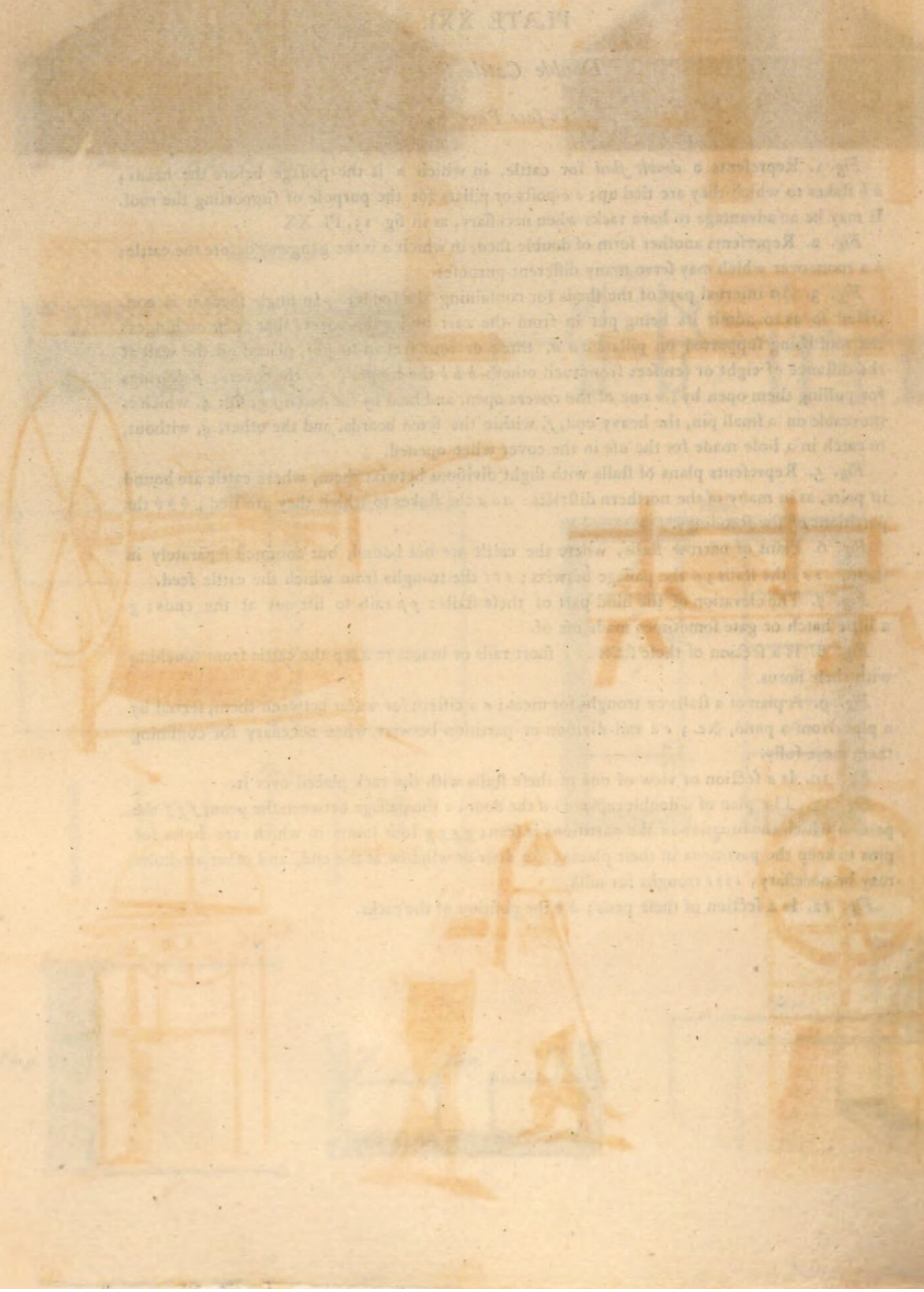
Fig. 9. A plan of a ſtall: *c c* troughs for meat; *d* a ciſtern for water between them, ſerved by a pipe from a pond, &c.; *e* a rail-diviſion or partition betwixt, when neceſſary for confining them more fully.

Fig. 10. Is a ſection or view of one of theſe ſtalls with the rack placed over it.

Fig. 11. The plan of a double *calf-pen*: *d* the door; *e* the paſſage between the pens; *f f f* the pens in which the ſituation of the partitions is ſeen; *g g g g* four joints in which are holes for pins to keep the partitions in their places; *h* a door or window at the end, and other air-holes may be neceſſary; *i i i i* troughs for milk.

Fig. 12. Is a ſection of theſe pens; *k k* the poſition of the racks.





DAIRY HOUSE & IMPLEMENTS.

Fig. 3.

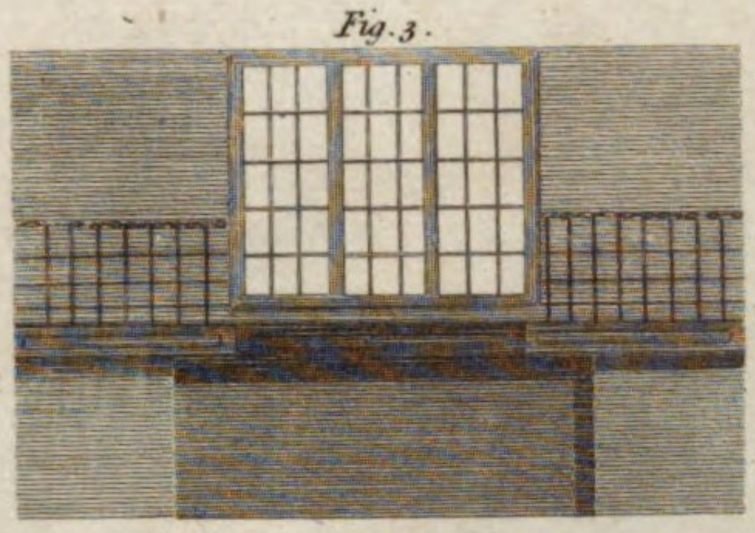


Fig. 2.

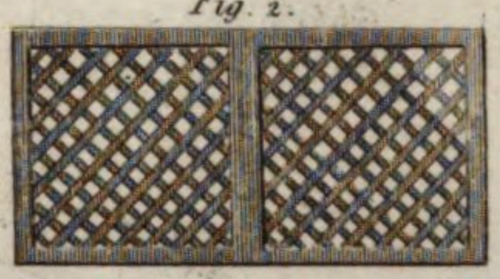


Fig. 1.

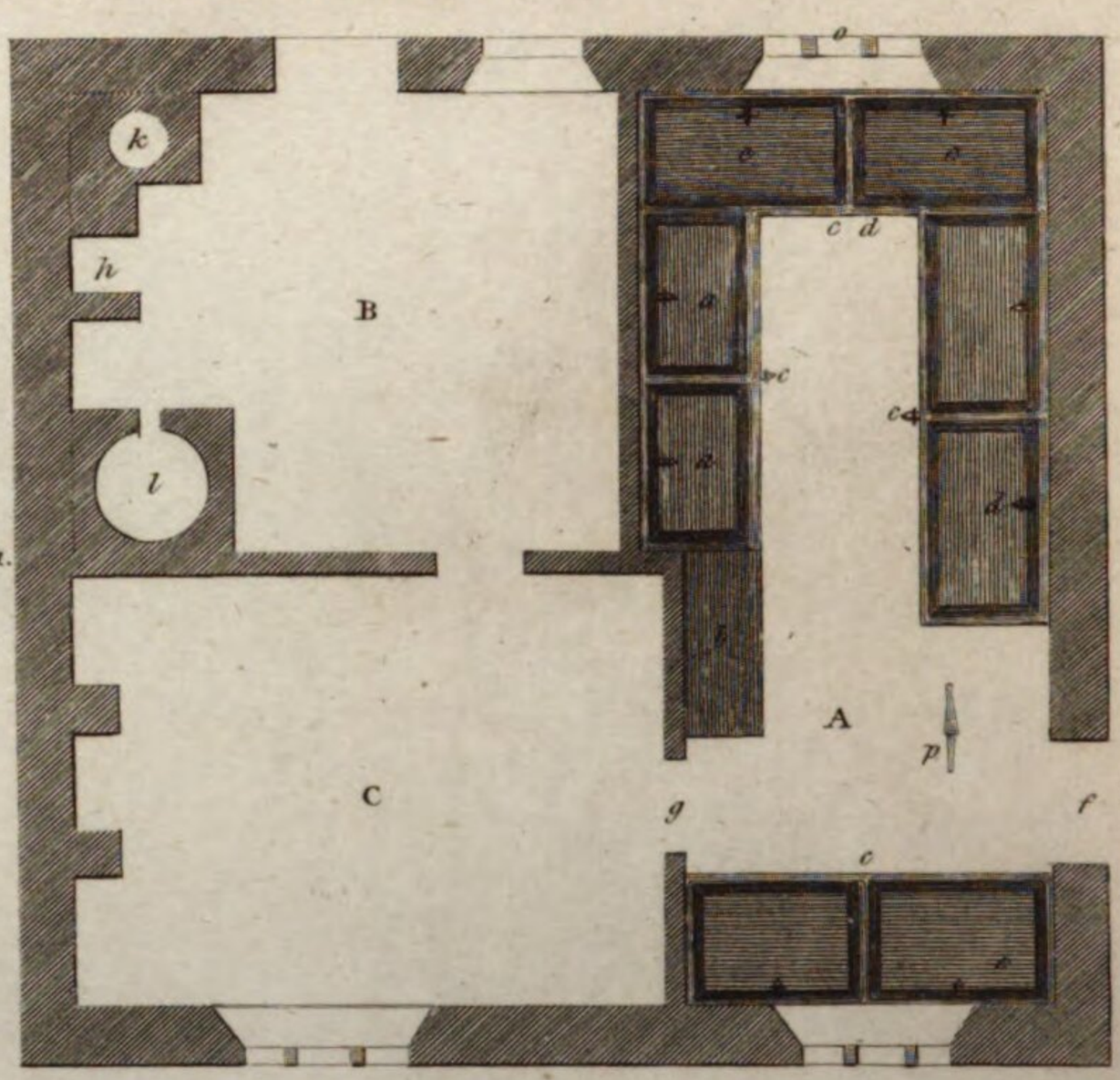


Fig. 4.

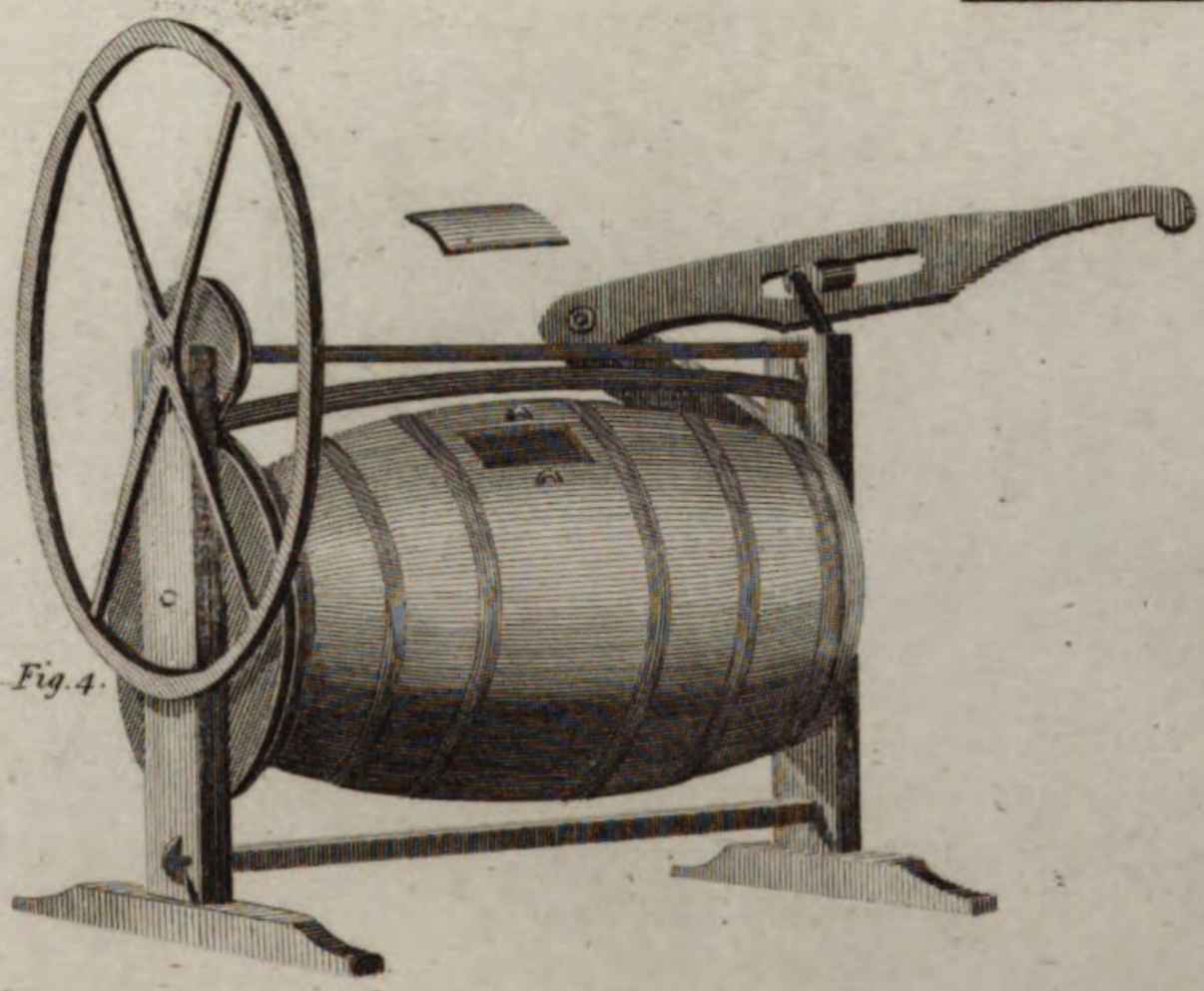


Fig. 8.

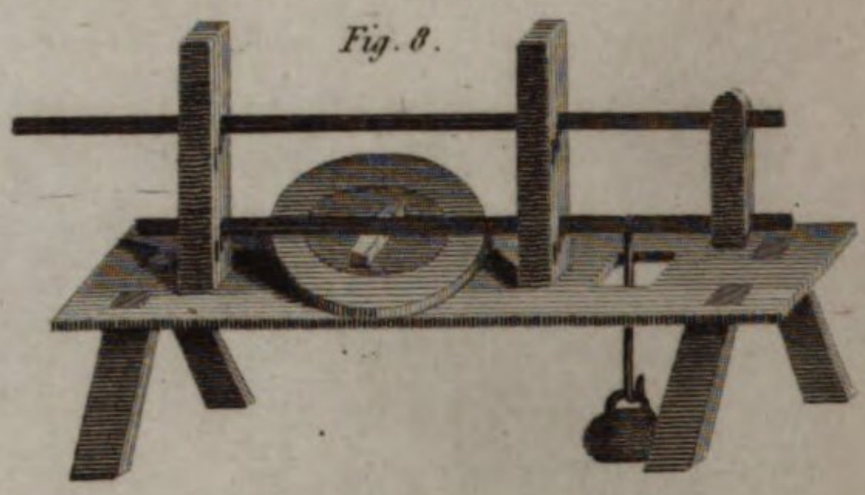


Fig. 5.

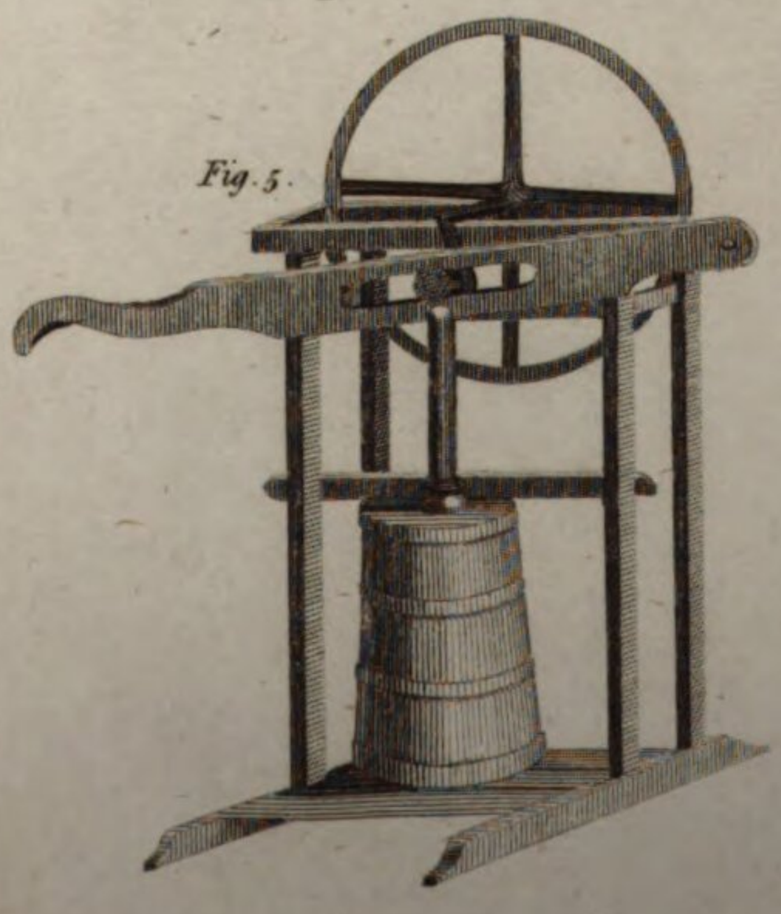


Fig. 7.

Fig. 6.

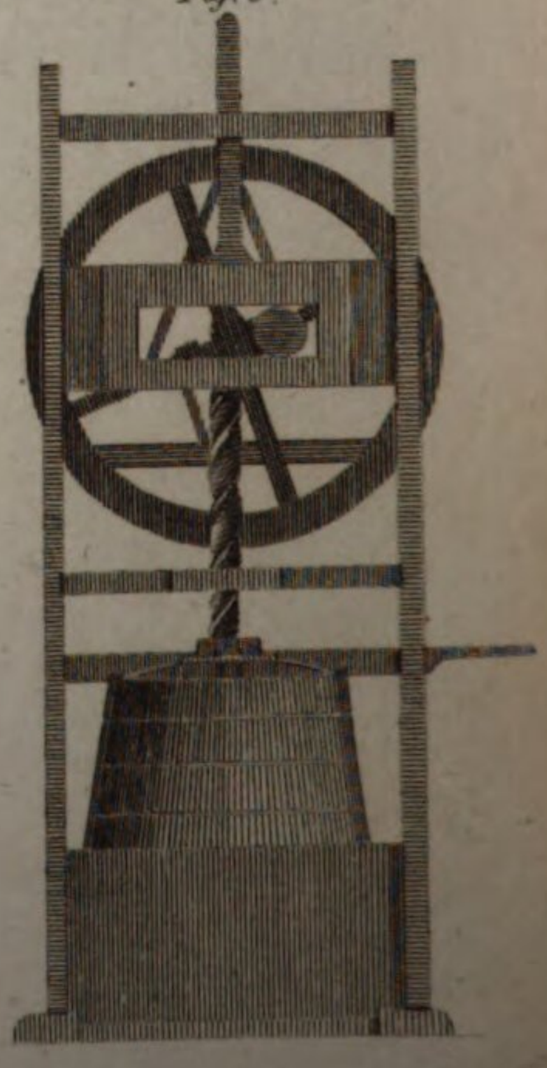


PLATE XXII.

Dairy-Houſe and Implements.

[*To face Page* 64.]

Fig. 1. Repreſents an improved form of Dairy, uſed by Mr. Wakefield, near Liverpool: in which A is the milk-houſe; *a a a* the coolers; *b* a ſlab for laying butter upon after it has been made up; *c c c* cocks for drawing off the milk from the coolers, one ſerving two coolers by the contrivance of a ſhort piece of leaden pipe from the holes, *o o o*, which are ſtopped by the plug *p*, being made ſufficiently long to extend above the ſurface of the milk; *d* a large cock to throw water upon the floor, which is laid with a little ſlope from that part; *e e e* cocks at the back part of the coolers for letting in water; *f* a door latticed, as ſhown at *Fig.* 2; *g* another pannelled door. B the churning-room; *h* a fire-place; *k* a boiler; *l* large boiler or copper for ſcalding implements or other uſes. C. a room for airing or drying utenſils, and may be uſed as a laundry. Over theſe may be made ſervants' lodging-rooms if neceſſary.

Fig. 3. A view of the inſide of the dairy at the end Q.

Fig. 4. The improved barrel-churn with wheel.

Fig. 5. An improved upright churn, put in motion by a crank and lever, which is very convenient and uſeful where large quantities of butter are not made.

Fig. 6. Rowntree's improved butter-churn.

Fig. 7. Bowler's *pendulum churn*: A A is the body of it; B an opening by which the cream is introduced; C the cover of the large opening, the ſmall hole on the oppoſite ſide not being ſhown; D the gudgeon on which the body hangs; E the upper larger pulley; F the ſmaller pulley fixed on the axis or gudgeon; G G the rod of the pendulum ſuſpended from upper pulley E; H bob of pendulum; I I the handle, moveable on a pin at *a*, ſwinging in the form of dotted line K K; L the trough for hot or cold water; M a projecting piece of wood for ſupporting the handle, I, when the churn is not at work.

Fig. 8. Is a cheeſe-preſs on the principle of the lever. Screw-preſſes are, however, common in moſt dairies, as being more convenient and more eaſily managed. In theſe caſes the ſtone, or weight, is fixed in a frame of wood; in the upper part of which the ſcrew acts ſo as to readily wind it up or let it down as may be neceſſary.

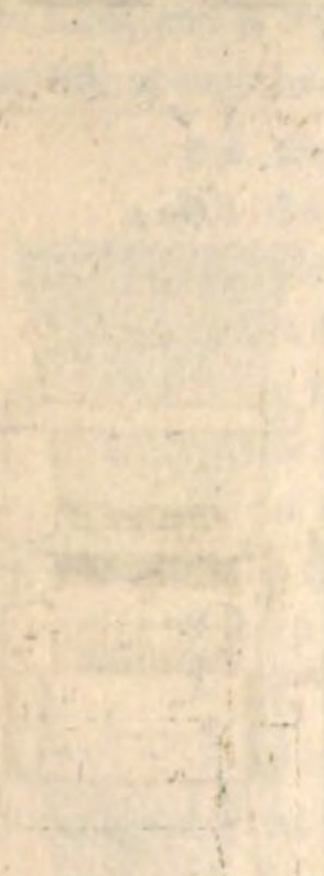
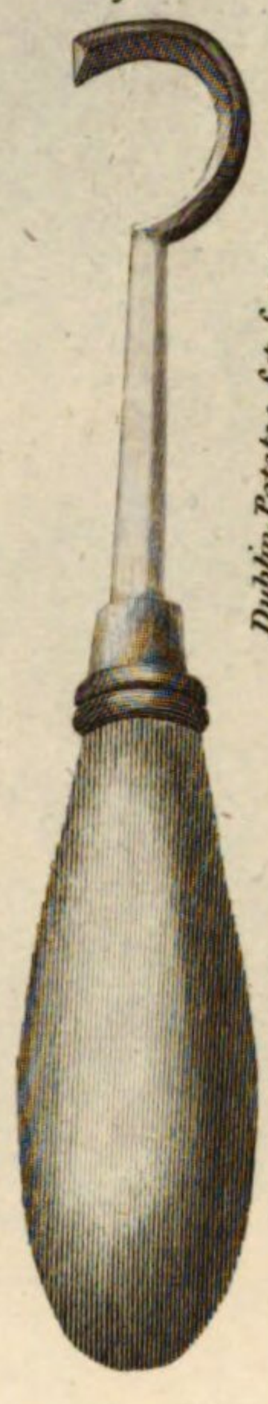


Fig 11

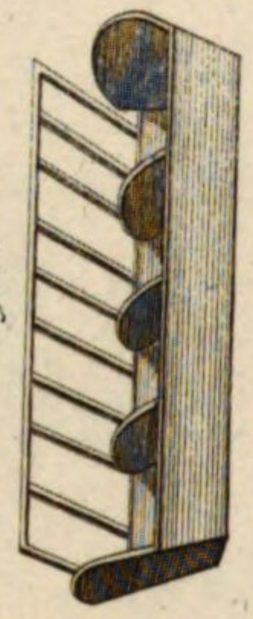


Dublin Potatoe Set Scoop.

Fig 10

Mr. Starks Potatoe Set Scoop.

Fig. 5.



Steam Boiler for Potatoes.

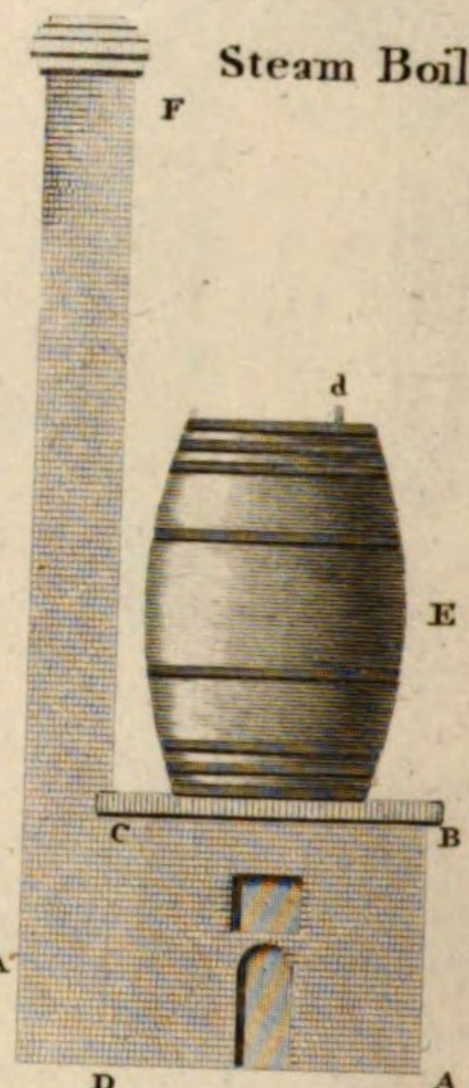


Fig. 1.

Fig. 6.

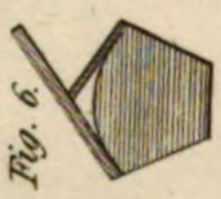
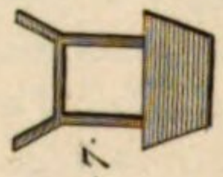


Fig. 9.

Fig. 8.

Fig. 7.



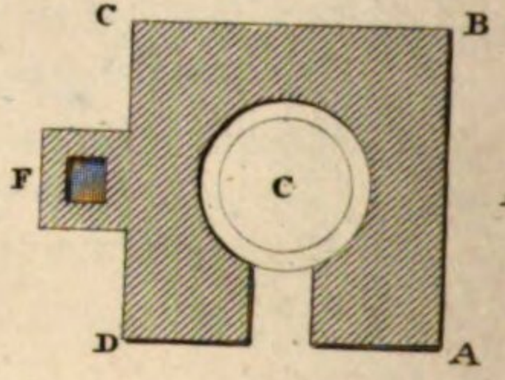
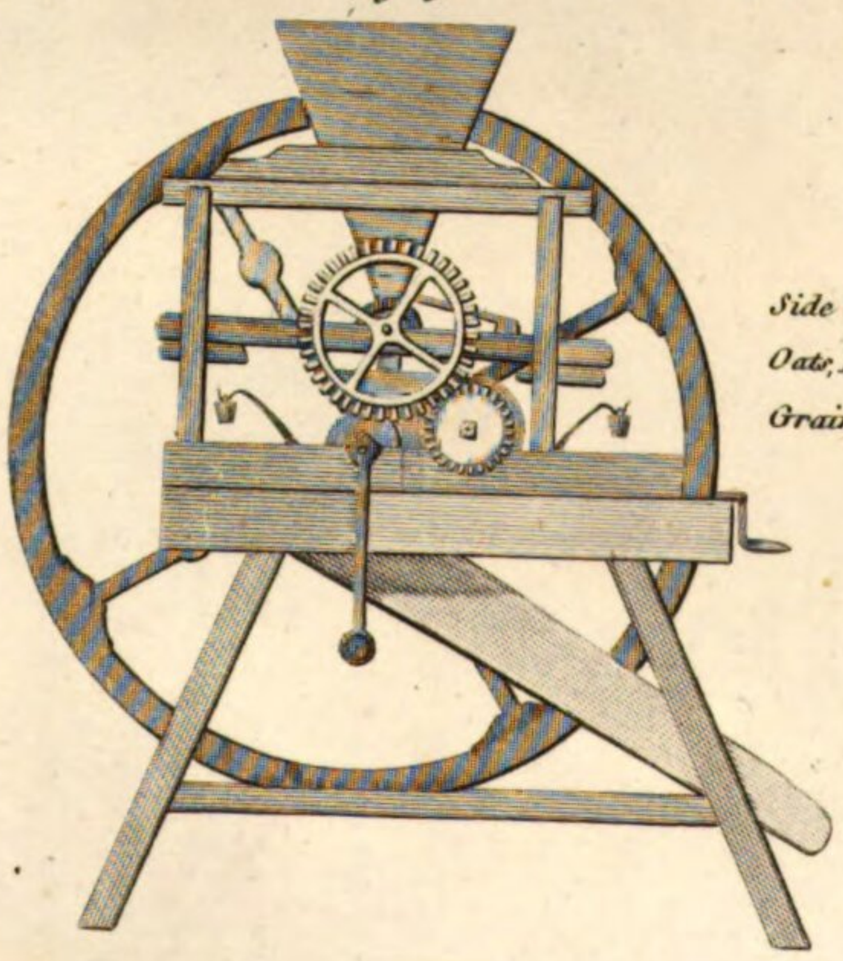


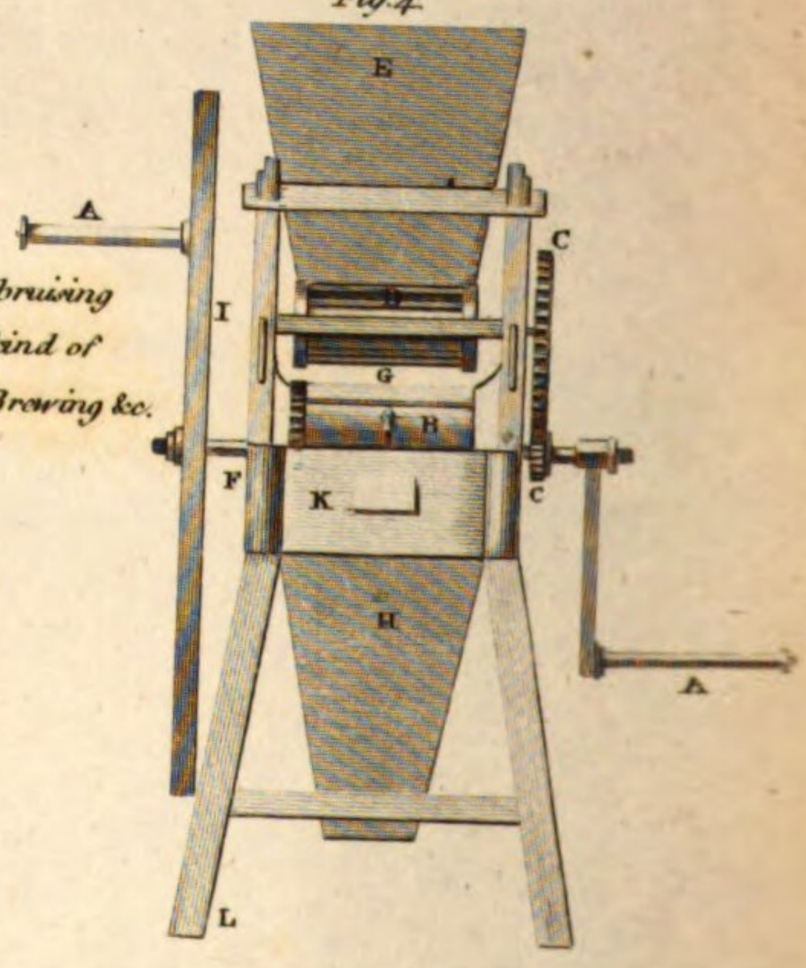
Fig. 2.

Fig. 3.



Side & End View of a Machine for bruising Oats, Beans, Peas, Barley or other kind of Grain for feeding Cattle, Malt for Brewing &c.

Fig. 4.



Printed for Richard Phillips, 71, St. Paul's Church Yard.

PLATE XXIII.

Steam Boiler and Bruiſing Machine.

[*To face Page* 64.]

Fig. 1. Is the repreſentation of a *Steam Boiler* for potatoes or other roots, in which the parts A B C D in it and in *fig.* 2. are formed of brick or ſtone, being conſtructed in a cubical form, about three feet in every direction. *a* the door of furnace; *b* the aſh-pit; *c* a ſhallow iron kettle twenty inches in diameter, and ſeven or eight inches in depth, placed over the furnace. B C a flat ſmooth ſtone covering the whole of the work, in the middle of which is a round hole cut out, to admit the iron kettle in a cloſe manner. E a caſk, the bottom of which is perforated with auger-holes and placed over the ſteam kettle, when filled about half full with water. The caſk is then filled with potatoes, and cloſely clayed all round, to prevent the eſcape of ſteam, and the cover put on cloſe. *d* a ſhort thick plug, put ſlightly in a hole in cover, to afford air, or rendered moveable by a leathern hinge. F flue or vent, which may be built to a houſe or any other place. When the potatoes are ſufficiently ſteamed, the roots are commonly removed by a wooden ſhovel, or by turning the caſk over. But it might be ſo contrived as to move on pivots in the middle of the boiler, in a frame, ſo as to be readily turned upſide down when neceſſary to empty it. It is made uſe of by Mr. Wakefield, near Liverpool.

Fig 3. Is a ſide view of Mr. Rowntree's machine for bruiſing different ſorts of grain, as well as peaſe, beans, &c. for the purpoſe of feeding horſe- or other ſorts of teams. It is likewiſe capable of application in the grinding of malt for brewing.

Fig. 4. Is an end view of the ſame machine. This machine is conſtructed with two iron rollers of different diameters, turned true on their axles or ſpindles, each roller having a cog or tooth wheel. A roller with grooves is fixed under the hopper, to receive the grain from the hopper and lay it on the two rollers. To one of the rollers is fixed a fly wheel. The machine is made to be worked by hand or any other power. The upper wood frame is made to ſlide, and is regulated by a ſcrew according to the ſize of the grain, and will bruiſe it more or leſs as may be required.

AA the handles.
BB the rollers for bruiſing the grain.
CC the cog or tooth wheels for turning the rollers.
D the fluted roller which receives the grain from the hopper E.
F the ſliding frame.
G the ſcrew for regulating the rollers.
H the ſhoot or trough for conveying away the grain from the rollers.
I the fly wheel for regulating the motion.
K two ſcrapers hanging on centres for keeping the rollers clean.
L the frame.

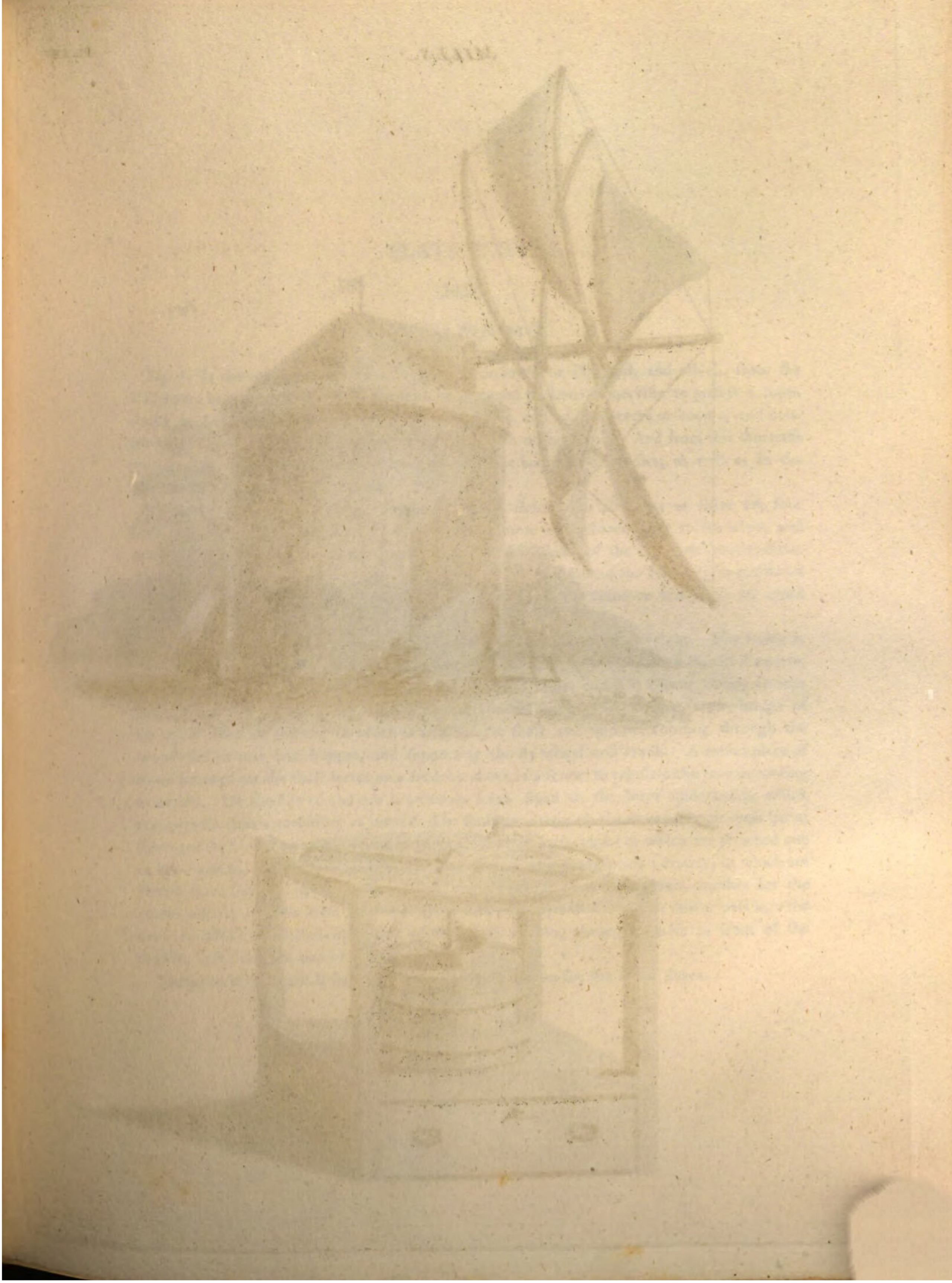
Fig. 5. Exhibits a form of hog-trough contrived ſo as to prevent waſte by ſpilling, from the hogs getting their feet in, by having a piece of deal nailed on the back of it.

Figs. 6. 7. and 8. Show the method of making the diviſion in hog-troughs, which need not go to the bottoms.

Fig. 9. Repreſents another method of preventing waſte, by having a ſhallow trough below, and above large deep troughs with open bottoms, to let the food paſs as it is conſumed from the trough below. When liquid food is employed the lower trough may be of ſtone, as ſeen at A.

Fig. 10. Is a potatoe ſet ſcoop invented by Mr. Slark, by which much of the ſubſtance of the potatoe may be ſaved.

Fig. 11. Is the Dublin potatoe ſet ſcoop for the ſame purpoſe.



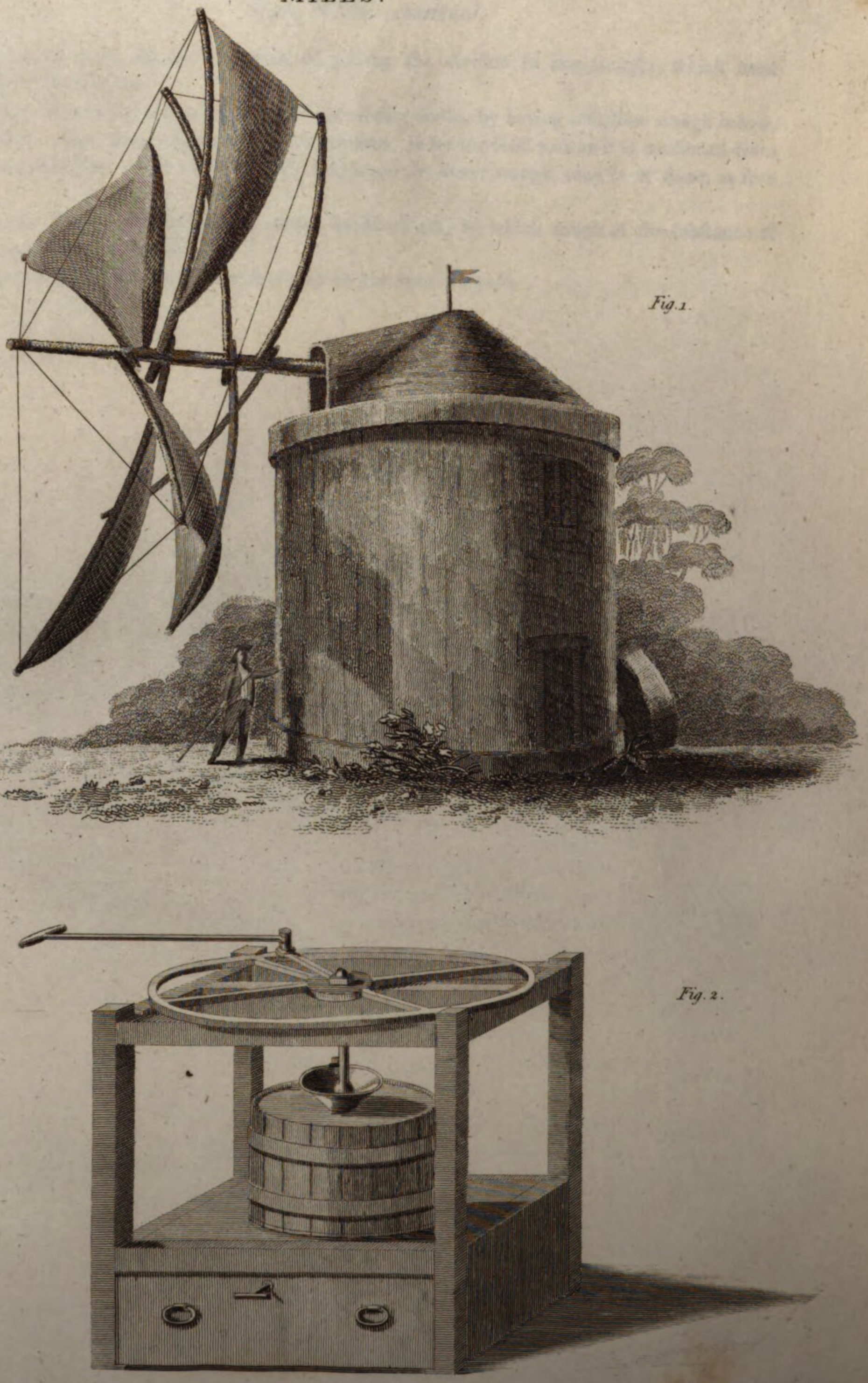


Fig. 1.

Fig. 2.

PLATE XXIV.

Mills.

[*To face Page* 64.]

Fig. 1. Is the repreſentation of a Windmill employed in Portugal, and which, from the differences in the conſtruction of the ſails, is ſuppoſed by Lord Somerville to poſſeſs a ſuperiority in having the broad part of the ſail at the end of the levers or booms, and conſequently equal reſiſtance is overcome with leſs length of branches. And from this ſhortneſs conſiderable ſaving is made in the timber of both the booms and ſpindles, as well as in the height, firſt coſt, and future repairs.

The advantages ariſing from uſing mills of this deſcription are, that as there are four booms, as well as four maſts for the ſails, they are more eaſily braced out to the wind, and in caſe of a ſudden gale are more eaſily caſt looſe, than thoſe of the common conſtruction. And as the ſails are placed in the beſt poſſible direction by means of the booms, it is preſumed that a mill built on this plan will do more work than any common mill with an equal quantity of canvaſs.

Fig. 2. Repreſents a horizontal Hand Corn Mill invented by Mr. Wright. The frame is three feet ſquare, and three and a half in height. The ſtones are eighteen inches in diameter, and incloſed in the tub ſupported by two croſs bearers; under which is a lever, having an iron pin or pivot, which runs through the centre of the bed-ſtone, into a ſocket in the bridge of the upper ſtone or runner, to which is attached the ſhaft and ſpindle, running through the eye of the runner and hopper, and ſupporting the fly wheel and crank. A round piece of wood faſtened on the ſhaft ſerves as a feeder; above is a ſcrew to regulate the feed according as turned. On the ſide of the tub is a thumb ſcrew fixed to the lever underneath, which regulates the ſtones according as turned. The ſhaft runs through the crown tree or croſs bar at the top of the frame, on which is the horizontal fly wheel and crank; to which are attached one or two handles, by which the mill is put in motion. Under the ſtones is a drawer, in which are placed three ſieves of different fineneſſes; one for taking away broad bran, another for the coarſe pollard, and the third for ſtopping the fine pollard, and letting the flower paſs into the drawer; which is effected by a ſort of iron fork running through a hole in front of the drawer, and fixing on one of the ſieves.

The price of the mill is ſixteen guineas, and one guinea for the ſet of ſieves.

PIGEON-HOUSES.

WHERE pigeons are bred for the purpoſe of deriving profit from them, the pigeon-houſe ſhould not only be large and roomy, but be placed in ſuch a ſituation that the pigeons may be fed with convenience, and without being diſturbed by the different operations that are conſtantly going on about the farm-houſe. The form of the houſe is probably not a matter of much conſequence, provided it be not made too deep in the inſide; pigeons diſliking to have their neſts low down. The floor ſhould be cloſely laid, and the ſides well plaſtered, and white-waſhed over. The roof may be covered by any convenient and ſuitable material, but tiles and ſlates are by much the beſt; thatch being warm in winter and cool in ſummer, may alſo afford a very good covering. The great objection to thatch for dovecoats is, that the pigeons are apt to ſcratch it off; but when the ridge is ſecured by ridge-tiles, and very light hurdles are laid on each ſide of it, that inconvenience may be prevented. The whole muſt be made perfectly ſecure againſt the entrance of rats and other vermin. Where buildings of this ſort are quite detached from the other offices, it is, perhaps, the beſt and cheapeſt method to erect them on pillars of brick or ſtone, or ſtrong poſts of wood, about ſix or ſeven feet high from the ground. In the latter caſe, the upper parts of the houſe may, likewiſe, be principally compoſed of wood; and the under part will ſerve as a ſhed for various uſeful purpoſes. If a ſtable or cow-houſe the better, as it will have a tendency to keep the pigeons warmer in winter, which is material to their breeding early in the ſpring, when they are of moſt value in the market. The chief objection againſt wood coats are, their being too cold in the winter, and too hot in the ſummer months.

The apertures or openings for the entrance of the pigeons, ſhould always have a ſouthern aſpect, as they delight in a ſunny ſituation; and they ought not to be too large: the common ſize is larger by much than is neceſſary. The number of holes muſt be regulated by the quantity of birds that are intended to be kept; it is better, however, to have too few than too many; as a great number of holes renders the dove-houſe cold, and in any caſe but few are made uſe of by the pigeons. Above theſe holes a piece of weather-boarding, ſufficiently large for keeping off the wet, ſhould conſtantly be fixed up. Theſe boards are generally made ſo ſmall that they do not keep off the wet effectually.

It is the general practice to make ſquare holes of board for the pigeons to lay and breed in; but a neater method is that of employing ſmall wicker baſkets open at the top for this purpoſe: theſe baſkets may either be compoſed of finer or coarſer mate-

rials, according to the inclination of the builder, or the expence he wiſhes to be at. Neſts made in this way take up but little room, and are readily removed whenever it is neceſſary to clean them, eſpecially if they be fixed up in a convenient manner.

CONVENIENCES FOR PREPARING *CATTLE FOOD.*

On farms where a large ſtock is almoſt conſtantly either kept, or occaſionally fattened with different ſorts of prepared vegetables, it becomes an object of great importance to have ſuch accommodations as are proper and advantageous for performing the buſineſs.

STEAM-BOILERS.

The practice of boiling, what may be termed the artificial food of animals, in ſteam, though extremely advantageous, not only in the ſaving of time and expence, but in promoting the condition and feeding of them, has hitherto been, perhaps, too little attended to. Potatoes are the kind of food moſt generally prepared in this way, and the method of doing it is perfectly ſimple and eaſy. It conſiſts in having a ſhallow iron kettle of about twenty inches diameter, and ſeven or eight inches deep, ſet over a furnace, and ſo fitted into brick-work or ſolid ſtone, as to be perfectly cloſe on every ſide. To the top of this kettle, a tub, having its bottom perforated with a number of ſmall augre holes, is adapted, the kettle being previouſly half filled with water. Potatoes muſt then be put into the caſk, and the joining betwixt it and the kettle be well ſecured by a luting of clay. A cloſe cover, provided with a proper air-hole, muſt then be put on, and the potatoes be ſteamed by making the water in the kettle boil. When ſufficiently done, which may be known by removing the lid, they may be taken out by means of a proper ſhovel, or the caſk may be turned and emptied into a barrow, or any other ſuitable convenience for receiving them; and a freſh quantity again introduced, if neceſſary.

The conſtruction of this boiler is extremely plain and eaſy; but other apparatus for the ſame purpoſe may be readily contrived, ſo as to ſuit the moſt extenſive farms. They might be ſo conſtructed, indeed, as that the ſteam from one kettle would be ſufficient for ſteaming ſeveral caſks of potatoes at the ſame time; and inſtead of ſuch caſks as theſe, large fixed boilers with moveable bottoms, ſo as to let out the potatoes upon proper vehicles being placed under them, might be employed. Caſks ſuſpended on cranes, with ſlides in their bottoms for emptying them by, would, perhaps, be a

ſtill more convenient contrivance. An uſeful apparatus of this ſort is made by Mr. Cook.

If boilers of this kind be ſituated near to the kitchen, they may be conveniently made uſe of for many purpoſes of the family.

CORN-CHESTS.

It is equally convenient and economical for the ſtable of even the common farmer to be provided with accommodations of this ſort; much time as well as waſte of corn being ſaved by it. Beſides, many other ſubſtances can, by ſuch means, be kept ready mixed with the corn; ſuch, for inſtance, as cut ſtraw, ſplit beans, and ſeveral other articles that may be advantageouſly employed in the feeding of horſes. A common bin or tub may, in ſome caſes, be ſufficient for the purpoſe; but on large farms, and where there is convenience, it is by much the beſt to have them conſtructed on the principle of the granary, which has been already deſcribed. Where this plan is adopted, the form ſhould be cubical, the bottom being made ſomewhat in the manner of a hopper, with a ſlider ſo contrived as that it may ſtand about eighteen inches from the floor, by which means ſufficient room will be given for taking out the provender. The ſpouts may be fixed from ſide to ſide with great eaſe and facility, and the air-holes be well ſecured by a grating of iron wire. If it ſhould be thought neceſſary, the ſlide may be faſtened by means of a ſmall lock and key.

CORN-STANDS.

Where the very beneficial and advantageous cuſtom of ſtacking grain is practiſed, it will be neceſſary to have proper ſtands or ſtaddles provided for ſecuring the corn, not only againſt damp and moiſture, but againſt the deſtructive waſte of rats and mice.

The mode of conſtructing theſe ſtands varies very conſiderably in different ſituations and diſtricts. In ſome places they are formed merely by placing two or three pieces of large timber length-ways, and then putting ſmaller ones croſs-ways upon them. This is, however, a plan by no means to be followed, as it provides no ſecurity for the bottom of the ſtack. In other caſes, a ſtrong framing of good timber is put upon poſts of wood, or what is better, of ſtone about two feet high, provided with caps, on which it reſts in a very ſolid and ſecure manner.

But the moſt ſecure method is to have theſe ſort of ſtands walled, and well guarded by good copings. Corn-ſtands, conſtructed in this way, have lately been erected on the

farms of his Grace the Duke of Bedford, at Woburn-Abbey, whoſe extenſive knowledge of the ſcience of agriculture ſeems not leſs than his zeal in promoting its improvement. The foundations in making theſe ſtands being ſunk a conſiderable depth into the ground, and the bottoms well laid, vermin cannot get to the grain of the ſtacks by working under them; and the upper part is rendered ſafe by a projecting coping of ſtone or wood. Subſtances ſhould not, however, be ſuffered to reſt againſt them, or the looſe corn to hang down during the time of building the ſtacks. In this way ſtacks of the parallelogramical form may be built to any ſize; but for ſmall ſtacks, eſpecially where wood is employed, the octagonal form of ſtand ſhould rather be preferred to the circular one, as the copings may be cut with leſs waſte, and from ſmaller timber; and it is juſt as eaſy to build a circular ſtack on an octagonal ſtand as on a circular one*.

Where ſtone can be eaſily procured, it is unqueſtionably the moſt proper material for the bottom; but brick, if properly made for the purpoſe, anſwers very well, eſpecially if proper care be taken in the laying of it. Slate, where it can be had at a reaſonable expence, will be a very good ſubſtance for the ſame purpoſe. Flag-ſtones would likewiſe anſwer extremely well; but neither ſlates nor flag-ſtones are neceſſary, if the foundation be laid ſufficiently deep to prevent the vermin burrowing under it.

Stands of this kind were made uſe of by the late Mr. Bakewell, with much advantage; and other farmers, in the ſame diſtrict, probably employed them before him.

BEE-STANDS.

Although bees have hitherto ſeldom been much attended to by farmers as objects of profit, they certainly ought not to be overlooked in the ſyſtem of rural economy. But in order to turn their induſtry to advantage, the farm muſt be provided with proper and ſufficient accommodations for them. Theſe are, perhaps, the moſt convenient and leaſt expenſive, when conſtructed in the form and manner of ſlight ſheds or ſtands, and made of good ſeaſoned wood, ſo framed that the fore part of the ſhed or ſtand may be about ſix or ſeven feet high, and the hind part five or ſix. The top, and alſo the ends and back, muſt be well covered with ſtrong boards. The inſide ſhould, likewiſe, have a lining of very thin deal boards, and be furniſhed with ſtrong ſhelves, ſo proportioned as to ſuit the number of hives, boxes, or glaſſes, that are to be placed in them. To the front, which is open, thin

* Communications to the Board of Agriculture, vol. I.

wooden ſhades ſhould be ſo fixed and contrived, that they may be raiſed and depreſſed at pleaſure, in order to protect the bees both from the too powerful effects of the ſun and the rain.

The apiary, or bee-houſe, ſhould always be placed in ſuch a ſituation as not to be much expoſed to winds, as theſe animals are liable to be very much diſturbed by them. It ſhould likewiſe, if poſſible, be near to water, and plenty of early blowing flowers, ſuch as flower-gardens, turnip, muſtard, and bean fields, &c.

SITUATION AND *ARRANGEMENT* OF *FARM-HOUSES* AND *OFFICES.*

HAVING thus diſtinctly conſidered the houſes and different ſorts of buildings which are neceſſary for the comfort and convenience of various kinds of farming, we ſhall proceed to ſhew the ſituations and arrangements which promiſe the moſt advantage in reſpect to the economy of human labour, the ſaving of expence in the conſtruction, and the prevention of waſte in the articles which they contain.

Where a choice of ſituation can be had for the farm-houſe and offices, it ſhould certainly be as near as poſſible to the centre of the farm, and rather elevated, by which means the various kinds of produce, as well as the manure of the farm-yard, may be conveyed to their proper deſtinations with the greateſt facility and diſpatch; it ſhould likewiſe be dry, well ſupplied with water, and the approach eaſy and convenient.

The three moſt expoſed ſides of a ſquare ſhould always, where it is poſſible, be choſen for the ſituations of the different offices; that to the ſouth being left free and open for the admiſſion of ſun and air.

Theſe circumſtances, however important they may be, ſeem to have been little regarded in the building of farm-houſes in general, as we frequently find them occupying not only the worſt, but the moſt inconvenient ſituations that the farms afforded. Where the form of the ground and other circumſtances are favourable, and readily admit of purſuing any deſign, the moſt pleaſing, though by no means the beſt, ſituation for the farm-houſe, is that of the middle of a regular front. It is always much better to have it at a ſmall diſtance from the offices and the farm-yard; from fifteen to twenty feet at each end will, in general, be ſufficient. Where uniformity is particularly attended to, theſe ſpaces may be occupied by naked walls, or what is better, a ſort of lean to ſheds may be formed from them for various uſeful purpoſes. It is alſo frequently neceſſary in the deſigns of farm-houſes, and other buildings, that the daily tranſactions of ſervants and labourers about ſuch houſes and offices ſhould at once be overlooked and examined. With this view

the common ſitting or work room ſhould have ſuch a poſition, as that the buſineſs of the houſe may be readily ſeen from ſome one part of it, while that of the farm-yard and out-buildings may be attended to from another.

In diſpoſing and connecting the different buildings and offices, much attention is likewiſe required, in order that they may be convenient and ſuitable to the particular buſineſs of the farm. The nature of the ſituation, and the ſtate of the ground, will for the moſt part afford the beſt directions for placing the drains and other conveniences for taking off the ſuperabundant moiſture, as well as the proper place for depoſiting the dung and collecting the urine into; and theſe again will, in a great meaſure, ſhew where the ſtables, cow-houſes, feeding-ſheds, root-houſes, and other offices relating to them, ſhould be ſituated. The barn ſhould obviouſly be at no great diſtance from them; adjoining to which, on the ſides, ſhould be the barn-yards and ſtraw-ſheds, the two ends forming the ſtraw-yards and ſtack-yards. In every caſe, perhaps, the ſtables ſhould be as much as poſſible detached from the other buildings, in order that they may be the more ſecure from fire. The granary, where neceſſary, ſhould always be near the barn, or even in it; if a threſhing-machine be erected, it may be very conveniently placed over it. The dairy ſhould be diſtributed in ſuch a way, that it may be equally convenient to the dwelling-houſe, and the cow-houſes and yards, and at the ſame time be as little as poſſible expoſed to either exceſſive heat or cold. The hog-ſties, as well as the poultry-yards, ſhould, in order to avoid labour, be near to the dairy, yet not ſo very near as to incommode it.

The diſtribution of the inferior ſort of buildings and conveniences muſt be regulated by the particular circumſtances of the ſituations; but the principal and leading conſideration, in directing every building, ſhould be the buſineſs for which they are deſtined, and the ſaving of time, labour, and trouble, in the performance of that buſineſs, by giving them the moſt ſuitable connection and diſtribution *.

The nature and arrangement of the houſes and buildings proper for the accommodations of farmers being thus explained, we may offer a few obſervations on the expence at which they may be conſtructed. This is, however, a point on which it is difficult to ſpeak with much preciſion, as various circumſtances, in reſpect to the ſituation and facility of procuring materials, muſt obviouſly make conſiderable differences in all ſuch eſtimates; beſides, the prices of materials, as well as labour, have conſiderable local variation; but, as far as any general rule will apply on ſuch ſubjects, it is probable that, provided the farm be not under ſixty or ſeventy pounds a-year, one, or, at fartheſt, two years' rent, will be fully adequate to the building of

* Beatſon in Communications to the Board of Agriculture, vol. I.

DAIRY FARM HOUSES & OFFICES.

Fig. 1.

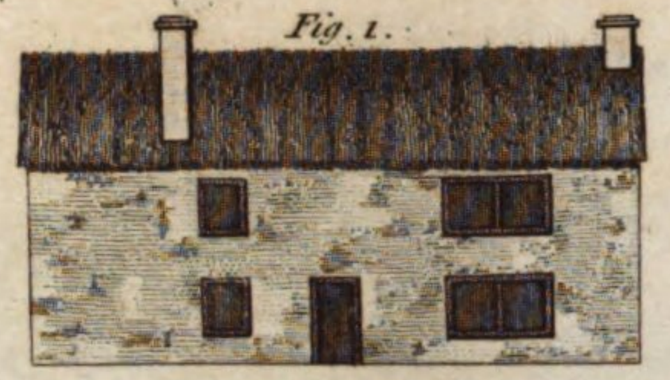
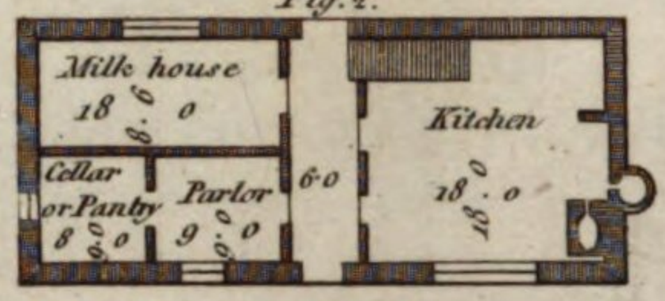


Fig. 2.



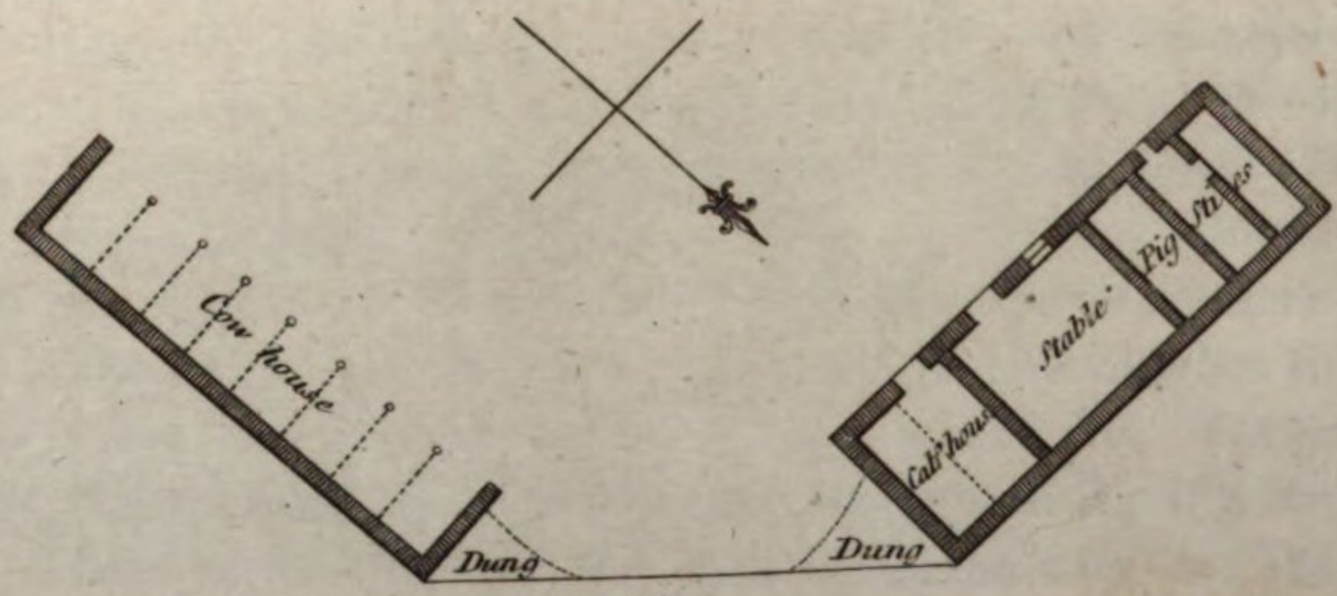


Fig. 3.

Fig. 4.

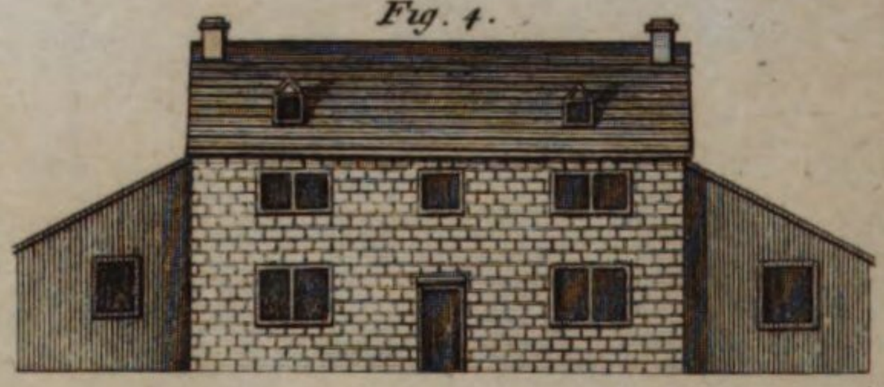


Fig. 5.

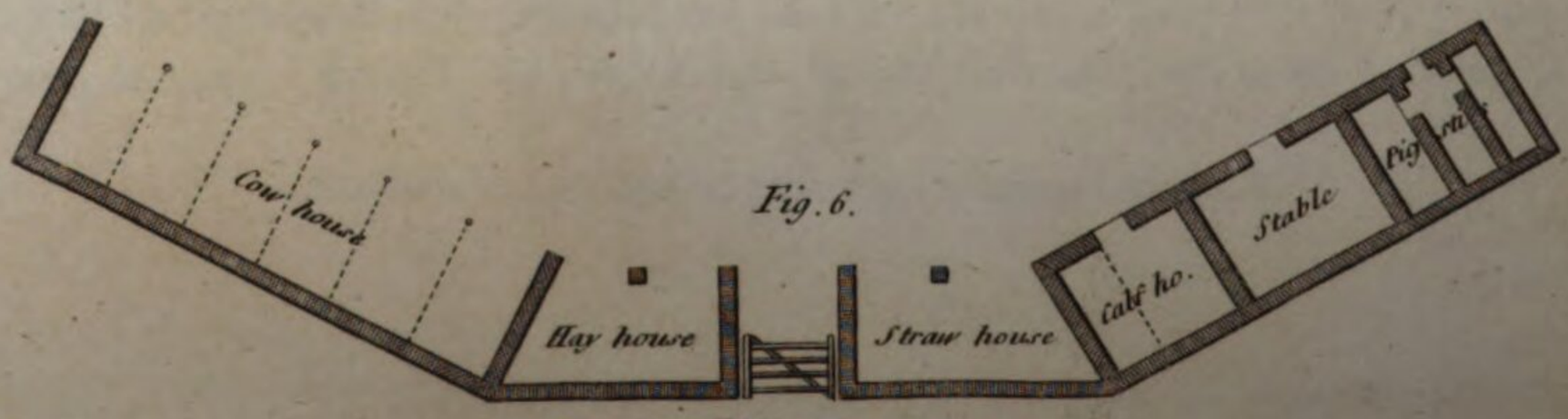


Fig. 6.

PLATE XXV.

Dairy-farm Houſes and Offices.

[*To face Page* 71.]

At *Fig.* 1. is repreſented the plan and elevation of a farm-houſe on a ſmall ſcale where dairying is practiſed.

Fig. 2. Is the ground plan.

Fig. 3. Shows the ſituation and connection of the ſheds and other out-buildings.

And at *fig* 4. is exhibited the plan and elevation of another farm-houſe on a more extenſive ſcale, for the ſame management.

Fig. 5. Shows the ground plan.

Fig. 6. Explains the nature and arrangement of the different buildings for the uſe of the cattle, &c.

Theſe houſes and offices are on the plan of Mr. Crocker, and deſigned for farms of from 60l. to 200l. a year, when the principal object is the dairy.

PLATE XXV.

Dairy-farm Houses and Offices.

[To face Page 71.]

At Fig. 1. is represented the plan and elevation of a farm-house on a small scale where dairying is practised.

Fig. 2. Is the ground plan.

Fig. 3. Shows the situation and connection of the sheds and other out-buildings.

And at Fig 4. is exhibited the plan and elevation of another farm-house on a more extensive scale, for the same management.

Fig 5. Shows the ground plan.

Fig. 6. Explains the nature and arrangement of the different buildings for the use of the cattle, &c.

These houses and offices are on the plan of Mr. Crocker, and designed for farms of from 60l. to 200l. a year, when the principal object is the dairy.

every office, independent of the houſe which is required for ſuch farms; and on all farms, of from three to four hundred pounds a-year, one year's rent, or even much leſs in particular caſes, will be ſufficient for building the dwelling-houſes: and probably on farms of any extent, five hundred pounds is an ample allowance for the dwelling-houſes, and one thouſand or twelve hundred for the reſpective offices. Various uſeful and convenient plans and eſtimates of farm-houſes and offices have been propoſed, for farms of different kinds, by Mr. Crocker, in a paper in the firſt volume of Communications to the Board of Agriculture. For thoſe which are wholly of the dairy kind, his eſtimates are theſe:

DAIRY-FARMS.

For a dairy-farm, of from ſixty to one hundred pounds per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, furnace, &c.	58	10	0
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, roof, ſtairs, &c.	92	17	0
Plaſterer, for ceiling, rendering, and plaſtering	16	3	0
Smith, for locks, hooks, and twiſts, latches, &c.	3	5	0
Glazier	10	6	0
Thatcher	8	13	0
Painter	0	12	0
	£190	6	0

Out-Houſes.

Maſon, for walls of the cow houſe, calf-houſe, ſtable, pig-ſty, &c.	28	3	6
Do. for pitching or paving do.	8	5	0
Carpenter, for roofs to the cow-houſe, calf-houſe, ſtable, pig-ſties, &c.	15	16	6
Do. for floors of hay-loft, doors, rack, and manger, &c.	12	18	6
Thatcher	7	10	0
Smith, for locks, &c.		16	6
Neceſſary-houſe	1	15	0
	75	5	0
Total	£265	1	0

For a dairy-farm, of from one hundred to two hundred pounds per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, ovens, furnace, &c.	92	4	6
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, roof, ſtairs, &c.	114	10	6
Plaſterer, for ceiling, rendering, plaſtering, and tiling	53	11	0
Smith, for locks, hooks, and twiſts, &c.	3	10	0
Glazier	15	13	0
Painter	0	18	0
	£280	7	0

Out-Houſes.

Maſon, for walls of the cow-houſe, calf-houſe, ſtable, &c.	31	15	6
Do. for pitching do.	8	5	0
Carpenter, for roofs to the cow-houſe, ſtraw-houſe, hay-houſe, ſtable, calf-houſe, and pig-ſties	17	12	6
Do. for floors of hay-loft, doors, calf-houſe, rack, &c.	10	18	6
Thatcher	6	13	0
Smith	0	11	0
Neceſſary-houſe to be placed in the garden	1	15	0
	77	10	6
Total	£357	17	6

Thoſe that are entirely employed in the growth of grain requiring more extent of buildings, the eſtimates of courſe ſtand conſiderably higher:

CORN-FARMS.

For a corn farm, of from one hundred to two hundred pounds per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, furnace, &c.	94	11	0
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, roof, ſtairs, &c.	125	3	3
Plaſterer, for ceiling, rendering, and plaſtering	25	11	8
Tiler	35	10	0
Smith	2	18	0
Glazier	14	14	0
Painter	18	0	
	£299	6	7

Out-Houſes.

Maſon, for walls of the cyder-houſe, ox-ſtalls, barns, ſtable, waggon-houſe, and granary, and for pitching	80	7	0
Carpenter, for roofs, &c.	66	12	3
Do. for floors, of do. and for rack, manger, windows, &c.	79	16	0
Thatcher	25	0	6
Tiler	11	5	0
Ceiling the granary	1	13	4
Smith	3	3	0
Neceſſary-houſe	2	10	0
	270	7	1

Total £569 13 8

For a corn farm, of from two hundred to three hundred pounds per annum.

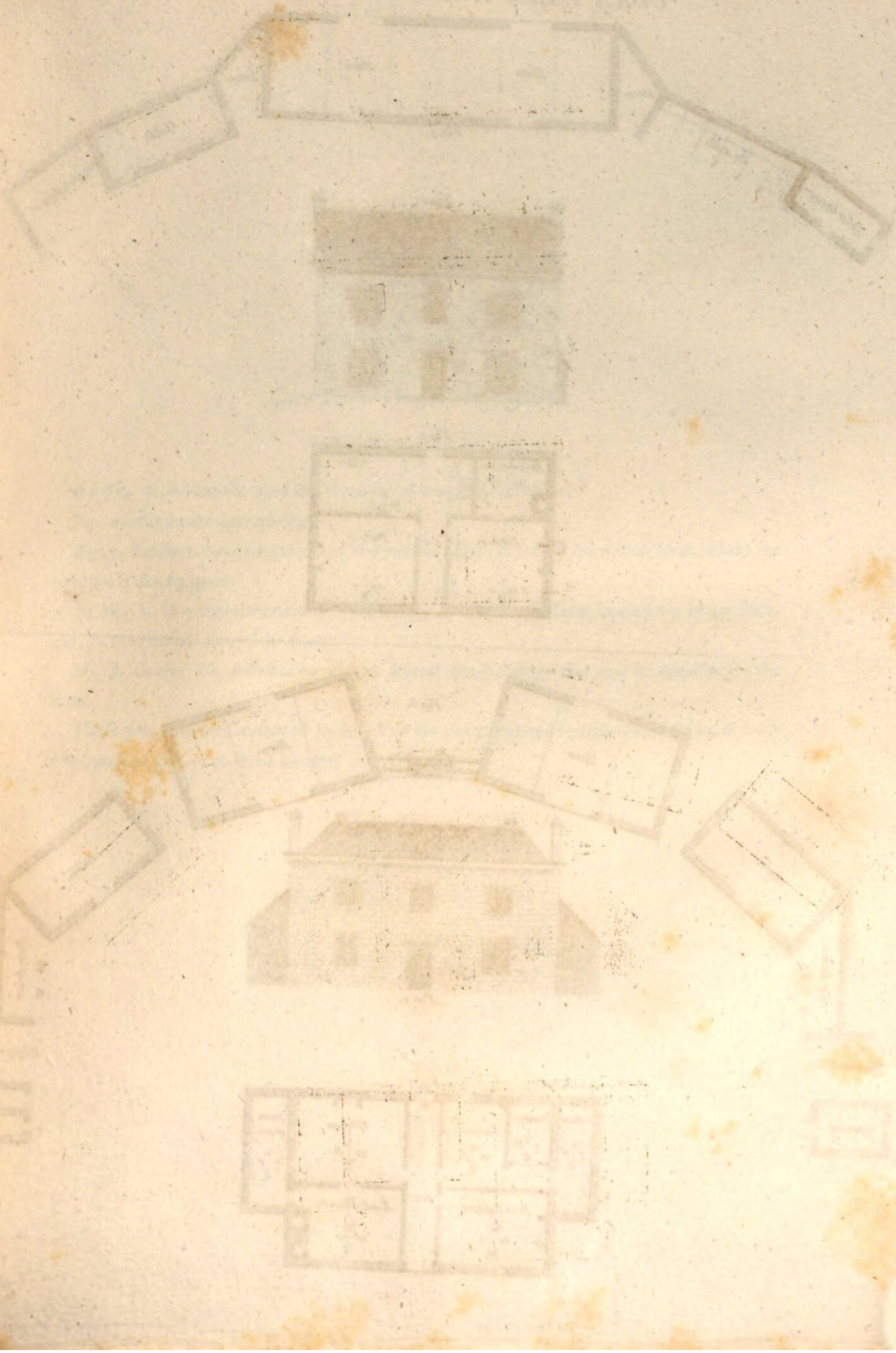
Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, &c.	139	5	4
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, ſtairs, &c.	154	4	8
Smith, for hooks, &c. &c.	4	12	0
Plaſterer and tiler	84	7	2
Glazier	19	9	0
Painter	1	15	0
	£403	13	2

Out-Houſes.

Maſon, for walls of pig-ſties, ſtraw-houſe, ſtables, barn, waggon-houſes, granary, and for pitching	107	15	0
Carpenter, for roofs	87	7	0
Do. for floors of granary, hay-loft, barns, and for rack, manger, &c.	85	2	6
Thatcher	40	14	0
Tiler, for the granary and for ceiling it	6	13	6
Smith, for locks, &c.	3	7	0
Neceſſary-houſe	2	12	6
	333	11	6

Total £737 4 8



CORN FARM HOUSES & OFFICES.

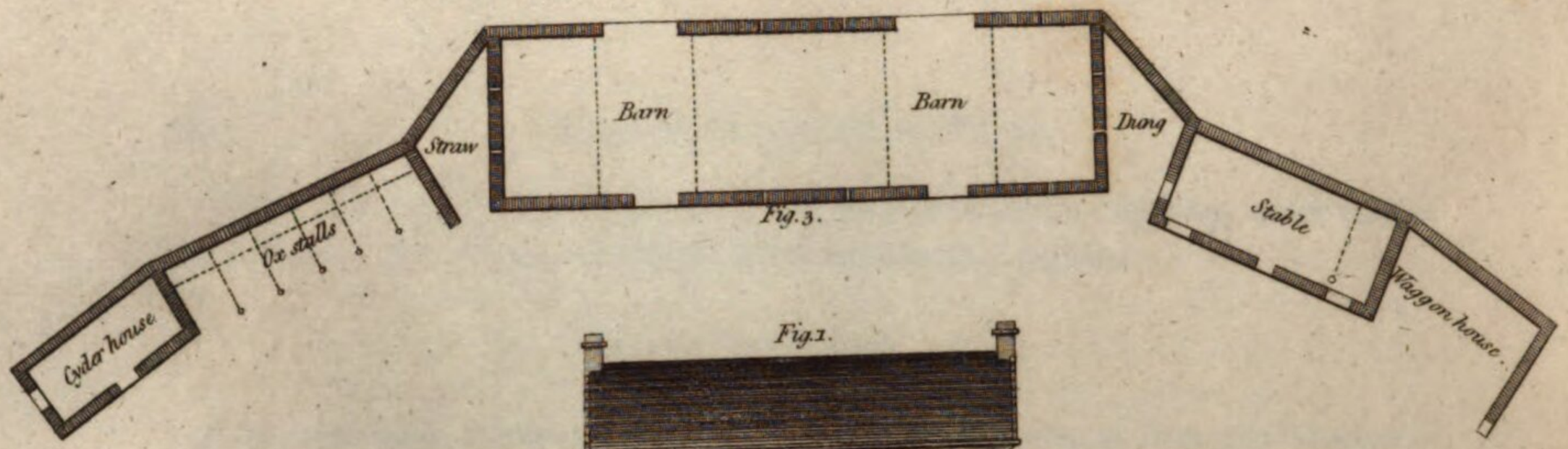


Fig. 3.

Fig. 1.

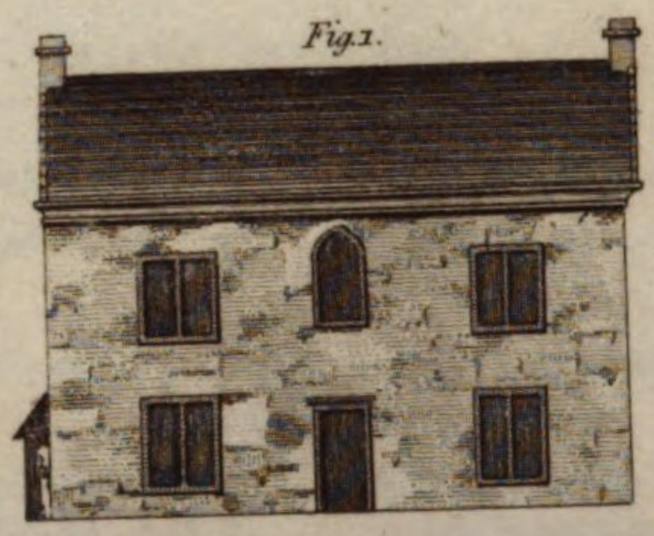


Fig. 2.

Fig. 6.

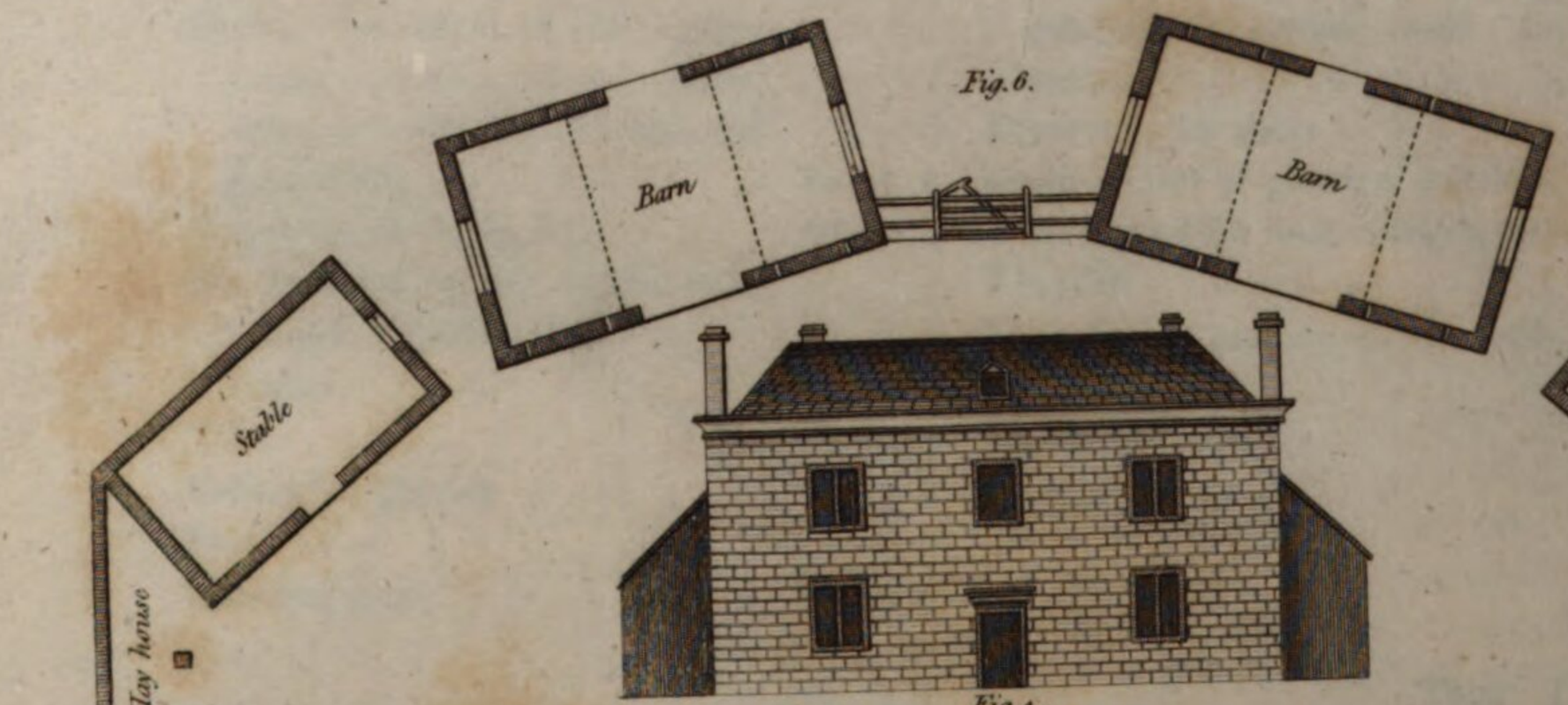


Fig. 4.

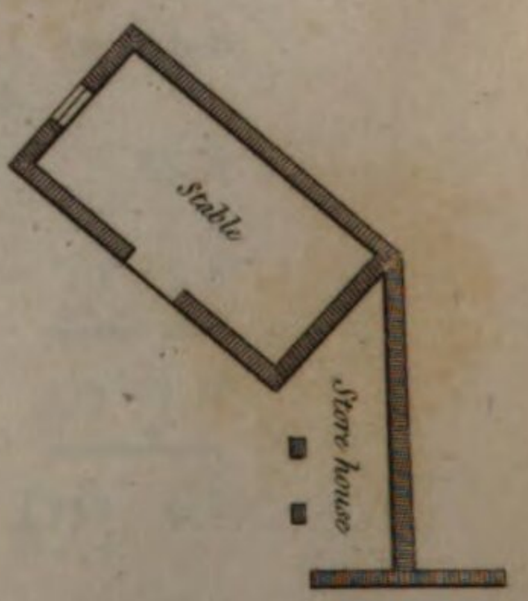


Fig. 5.

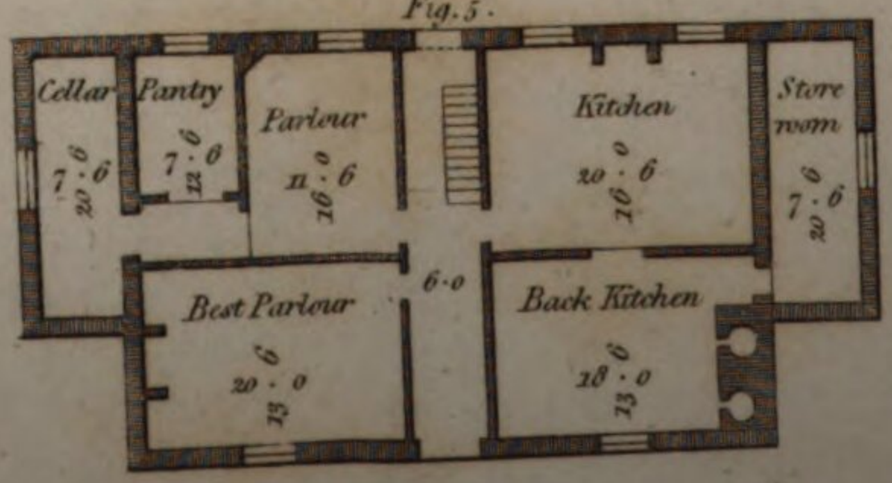


PLATE XXVI.

Corn Farm Houſes and Offices.

[*To face Page* 72.]

At *Fig.* 1. is ſeen the plan and elevation of a ſmall farm-houſe.

Fig. 2. Shows the ground-plan.

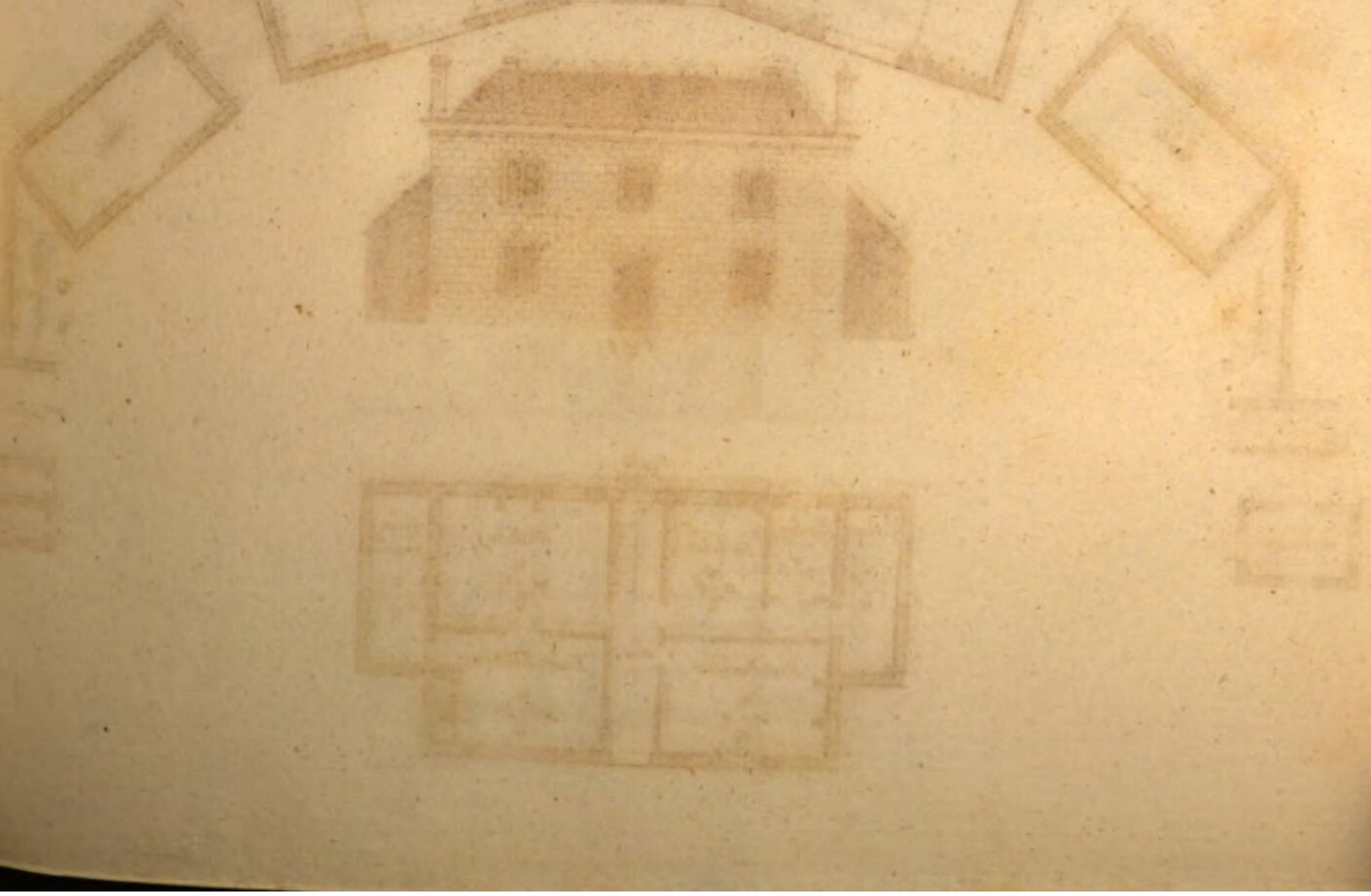
Fig. 3. Exhibits the arrangement of the various offices neceſſary for a ſmall farm, where the produce is chiefly grain.

At *Fig.* 4. is a repreſentation of the plan and elevation of a farm-houſe on a larger ſcale.

Fig. 5. the ground-plan of the ſame.

Fig. 6. Shows the diſtribution of the ſeveral out-buildings that may be requiſite for the farm.

Theſe plans are recommended by Mr. Crocker ; as calculated to ſerve grain-farms of from one hundred pounds to three hundred pounds a year.



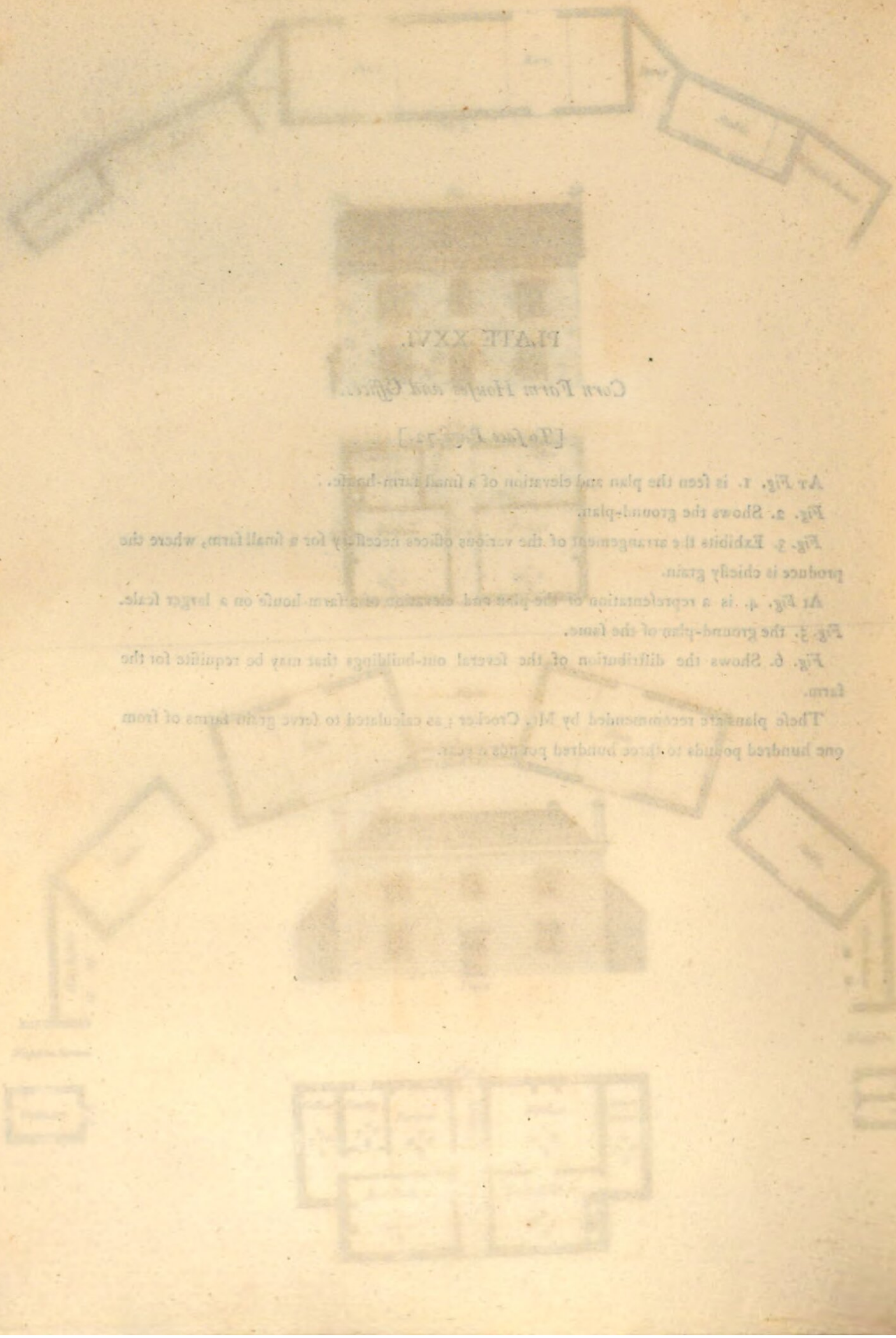


PLATE XXVI.

Corn Farm House and Offices.

[To face Page 72.]

At Fig. 1. is seen the plan and elevation of a small farm-house.

Fig. 2. Shows the ground-plan.

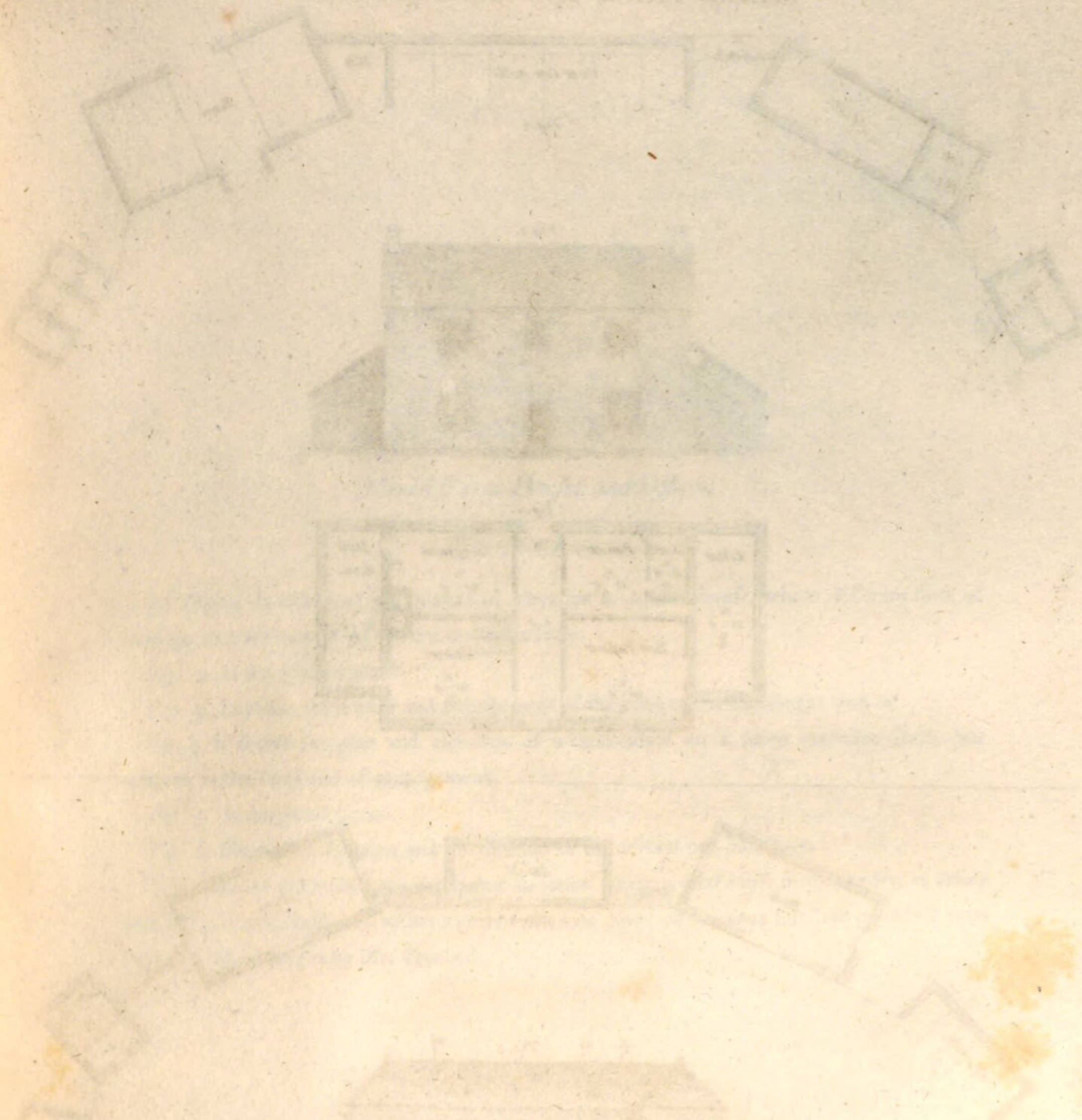
Fig. 3. Exhibits the arrangement of the various offices necessary for a small farm, where the produce is chiefly grain.

At Fig. 4. is a representation of the plan and elevation of a farm-house on a larger scale.

Fig. 5. the ground-plan of the same.

Fig. 6. Shows the distribution of the several out-buildings that may be requisite for the farm.

These plans are recommended by Mr. Crocker; as calculated to farm grain farms of from one hundred pounds to three hundred pounds a year.



MIXED FARM HOUSES & OFFICES.

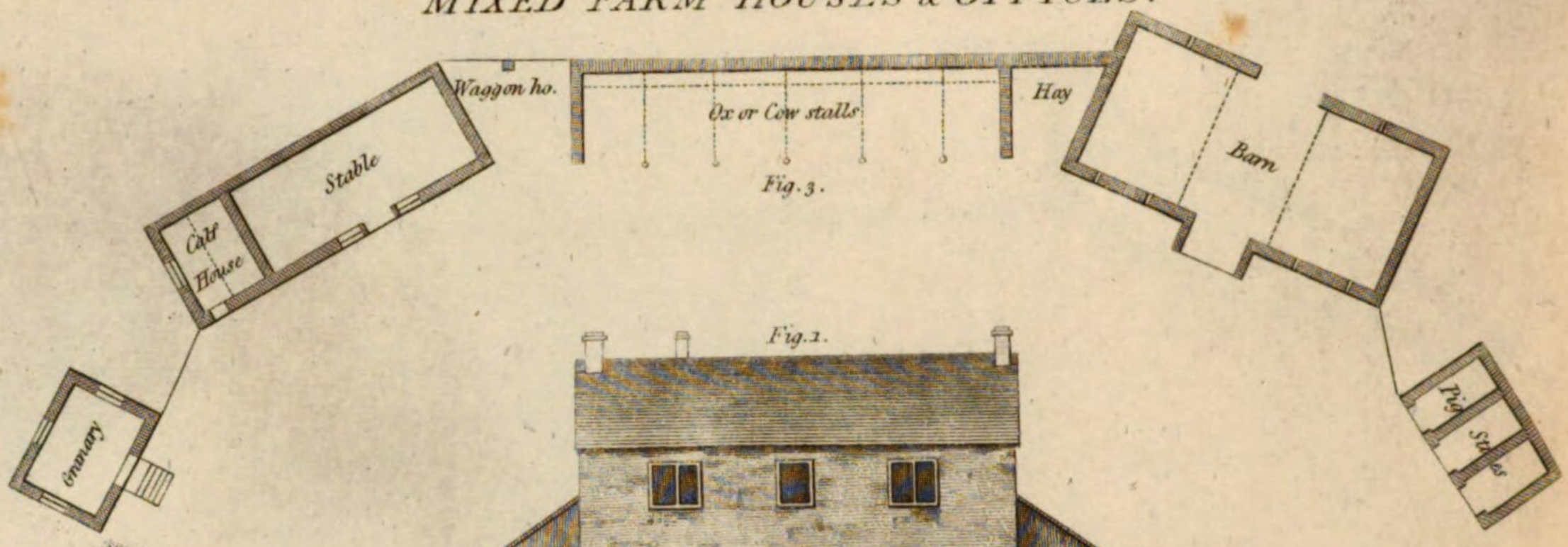


Fig. 3.

Fig. 1.

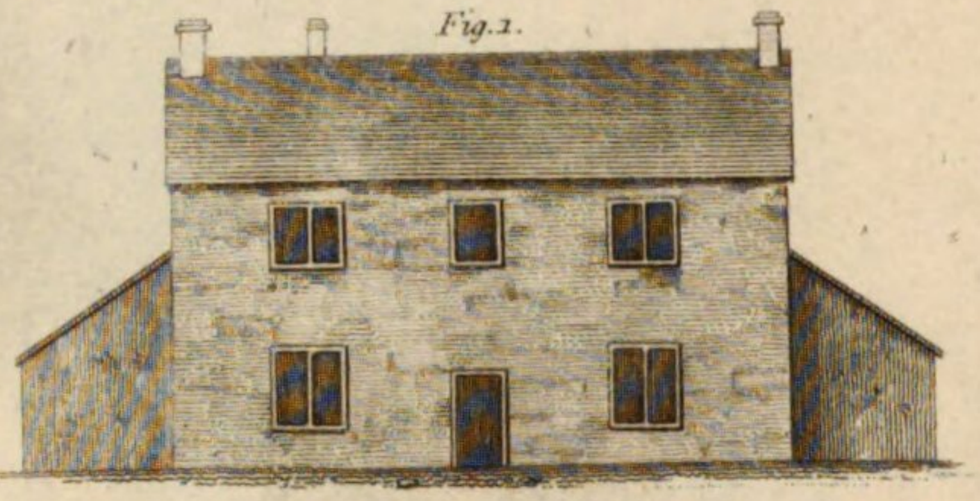
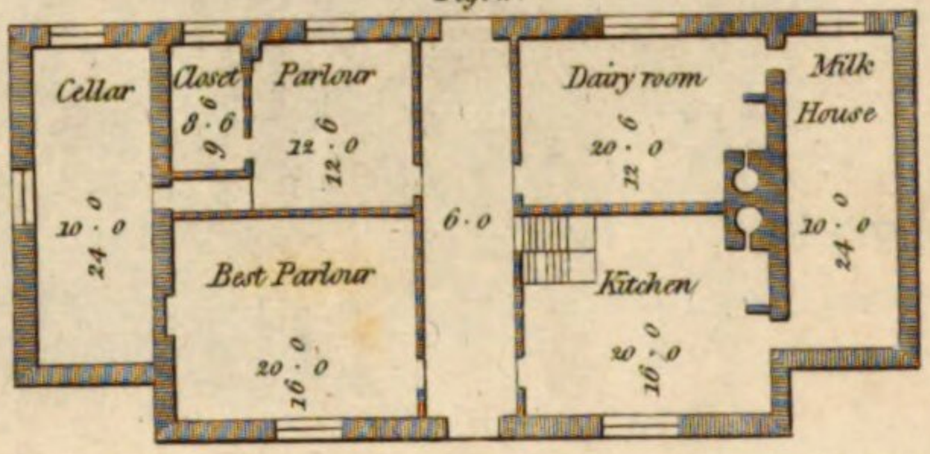


Fig. 2.



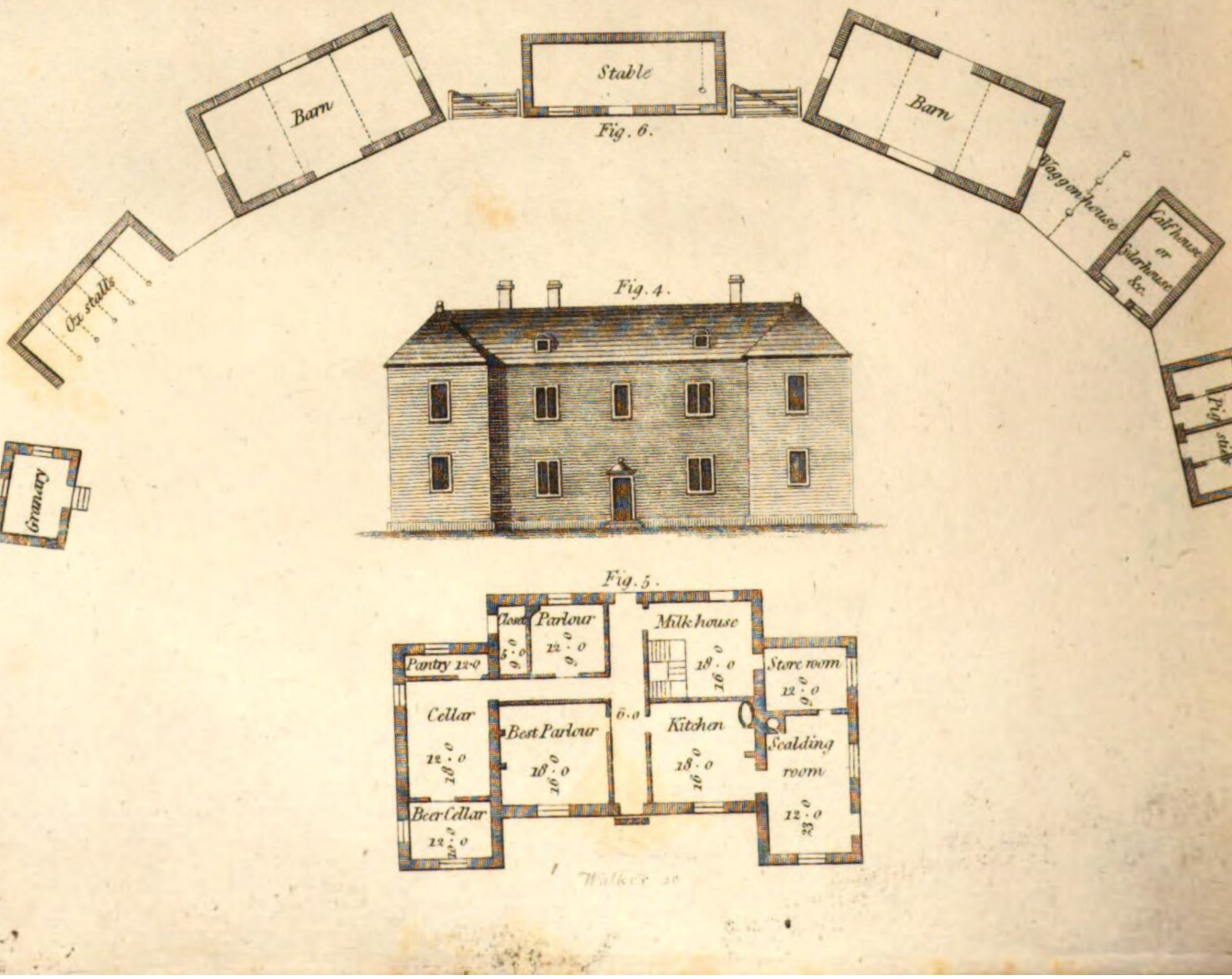


Fig. 6.

Fig. 4.

Fig. 5.

Walker sc

PLATE XXVII.

Mixed Farm Houſes and Offices.

[*To face Page* 72.]

AT *Fig.* 1. is exhibited the plan and elevation of a farm-houſe, where different ſorts of management are carried on upon a moderate ſcale.

Fig. 2. Is the ground-plan.

Fig. 3. Explains the nature and arrangement of the various out-buildings: and at

Fig. 4. is ſhown the plan and elevation of a farm-houſe on a more extenſive ſcale, but adapted to the ſame ſort of management.

Fig. 5. Is the ground-plan.

Fig. 6. Shows the ſituation and diſtribution of the ſeveral out-buildings.

Theſe houſes and buildings are adapted to farms where a mixed ſort of huſbandry, as arable and dairy, is practiſed, and which extend from two hundred to four hundred pounds a year. They are after deſigns by Mr. Crocker.

PLATE XXVII.

Model Farm Houses and Offices.

[To face Page 72.]

At Fig. 1. is exhibited the plan and elevation of a farm-house, where different sorts of management are carried on upon a moderate scale.

Fig. 2. Is the ground-plan.

Fig. 3. Explains the nature and arrangement of the various out-buildings: and at

Fig. 4. is shown the plan and elevation of a farm-house on a more extensive scale, but adapted to the same sort of management.

Fig. 5. Is the ground-plan.

Fig. 6. Shows the distribution and distribution of the several out-buildings.

These houses and buildings are adapted to farms where a mixed sort of husbandry, as arable and dairy, is practised, and which extend from two hundred to four hundred pounds a year.

They are after designs by Mr. Crocker.

There are others, which partake both of the nature of the corn and the dairy farm, in which a variety of buildings muſt of courſe be required; the eſtimates for theſe are conſequently ſtill higher:

MIXED FARMS.

For a corn and dairy farm, of from 200 to £300. per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, &c.	147	7	0
Carpenter, for lintels, window-frames, doors, beams, and joiſts, partitions, ſtairs, roof, &c.	142	19	6
Plaſterer, for rendering, plaſtering, &c.	44	6	0
Smith, for locks, &c.	5	10	0
Thatcher	16	10	0
Glazier	21	6	0
Painter	2	0	0
	£379	18	6

Out-Houſes.

Maſon, for walls to the granary, calf-houſe, ſtable, ox-ſtalls, pig-ſties, and for pitching	71	12	0
Carpenter, for roofs to granary, calf-houſe, ſtable, waggon-houſe, ox-ſtalls, barns, pig-ſties, &c. and for floors to granary, barns, &c. &c.	102	17	0
Thatching, tiling, and ceiling the granary	33	12	6
Locks, &c.	3	8	0
Neceſſary-houſe	3	13	6
	215	3	0
Total	£595	1	6

For a corn and dairy farm, of from 300 to £400. per annum.

Houſe.

	£.	s.	d.
Maſon, for walls, chimneys, floors, oven, &c.	143	11	0
Carpenter, for lintels, window-frames, beams, and joiſts, partitions, ſtairs, roof, &c.	172	5	0
Plaſterer, for rendering, plaſtering, and ceiling do.	69	0	0
Smith	6	5	0
Glazier	26	0	0
Tiler	63	0	0
Painter	2	10	0
	£482	11	0

Out-Houſes.

Maſon, for wall of granary, cow-houſe, barns, ſtables, cyder-houſe, and pig-ſties, and for pitching	123	9	6
Carpenter, for roofs of granary, cow-houſe, barns, ſtables, waggon-houſes, cyder-houſe, &c. and for floors of granary, barn, and hay-loft, corn-binns, &c. &c.	122	0	6
Thatcher	24	4	0
Tiling and ceiling the granary	6	16	0
Smith	3	8	0
Neceſſary-houſe	3	19	0
	283	17	0
Total	£766	8	0

In the conſtructing of new farm-houſes and buildings great ſavings may always be made where there are old erections, by making uſe of different kinds of old materials which are produced from them *.

* Beatſon's Communications to the Board of Agriculture, vol. I.

As all buildings of this ſort ſhould be made as durable and laſting as poſſible, the materials that are employed ſhould always be of the beſt kinds. It is remarked by an intelligent practical writer, that " tiles or ſlate are the beſt covering for houſes; but barns and ſtables ſhould be thatched, becauſe workmen are always careleſs, in laying corn and hay into them, and generally puſh the tiles off with their prongs; and beſides, theſe buildings, when empty, collect a great deal of wind, which is apt to diſlodge them, unleſs they are pointed in the inſide, which increaſes the expence conſiderably, and is never laſting. Reed is the beſt of all covering for barns, ſtables, cart-houſes, &c. There is, he ſays, a ſort of reed which grows in fens, marſhes, and wet-lands, ſo excellent for this uſe, that a moderate coat, if it be well laid on, will endure at leaſt half a century, with very little expence of reparation: and it is a fact beyond contradiction, that the timber uſed in roofing will laſt thirty years longer when covered with reed, than it will when covered with tiles. The next beſt covering to this is, he thinks, the *Somerſetſhire-reed;* which is nothing more than the ſtrongeſt wheat-ſtraw which can be met with, combed clean from weeds, having the ears of the corn cut off, inſtead of being thraſhed, and ſo laid on upon the building in whole pipes, unbruiſed by the flail. This latter reed may be had in any other county, as well as *Somerſetſhire*, in ſufficient quantity; and it is abſurd, in the laſt degree, he ſays, to make uſe of ſtraw for thatching in any other way, becauſe the difference of expence in the preparation is a mere trifle, compared with the difference of duration between the *Somerſetſhire thatch* and that of other counties. The common, injudicious, ſlovenly practice of beating the ſtraw to pieces with the flail, and then laying it on with ſome of the ſeeds and many weeds in it, cauſes it very often to grow quite green, after it is laid upon the building; and being bruiſed in all parts, to collect and retain the wet, much more than it would if the ſtraw were whole, and conſequently to become quite rotten in a few years. When ſtraw is deſigned for thatching, it is a good way to cut the corn rather earlier than ordinary*."

Where tiles are employed, they ſhould be well made, and kept well pointed with lime both on the inſide and the out, as often as may be neceſſary; as without attention in theſe reſpects they form a very inſufficient roofing for houſes, from their readily admitting rain and ſnow.

In regard to the timber moſt proper for building with, the author juſt mentioned ſays, " that he knows of none that is to be preferred to Spaniſh-cheſnut, where it can be had, becauſe it is very pleaſant to work, and as durable as oak, though it ſeldom bears the price of it. In maritime counties, where oak ſells well, and deals

* Kent's Hints, p. 149.

are tolerably cheap, it is beſt to diſpoſe of the one, and buy the other; becauſe oak is generally cut to waſte in moſt repairs, and deals may be bought of any ſcantling that may be required.

"In all paling, battoning, and other fences about the homeſtall, nothing is, he thinks, more uſeful than pollards; and they ſhould always be made uſe of on ſuch occaſions, becauſe they are generally the produce of the farm, of little value, and ſave better timber. Sometimes they are uſeful in ſheds, and ſmall buildings, for cattle. Bricks are a very conſiderable object, and great care ſhould be taken in getting them of a good quality. Upon moſt eſtates, of any conſiderable ſize, brick-earth, or clay, may be met with; and, where this is the caſe, they may be always made, and burnt in clamps, for one-third leſs than they can be bought at the kilns, and equally good in quality. He has had a great number burnt in this manner, from eleven to fourteen ſhillings a thouſand, in different counties. The medium price is twelve ſhillings a thouſand where fuel is reaſonable. Beſides the difference in price, there is generally a great ſaving in carriage, when gentlemen burn their own bricks. No material in building requires greater inſpection than mortar, in which maſons are apt to be deficient. Two things are to be attended to: the quality of the different articles, and the manner of mixing them."

It has been well obſerved, by another practical writer, who ſeems to have examined the ſyſtems of farming carried on in different diſtricts with conſiderable attention, that though, in general, "the ſize of the farm, and the ſyſtem of huſbandry adopted, muſt regulate the extent as well as the ſort of buildings to be erected; yet, in order to introduce and carry on ſpirited agriculture, ſufficient accommodation in regard to houſes is neceſſary. Accordingly he has found, that in every part where the proprietors are negligent in furniſhing their tenants with proper farm-buildings, or granting a reaſonable allowance for that purpoſe, agriculture, as well as all the other branches of huſbandry, remains in a languiſhing ſtate. But that, on the contrary, wherever ſubſtantial and commodious farm-offices have been built, whether at the expence of the proprietor or tenant, improvements in agriculture have always ſucceeded*."

This not only ſhews the great advantage of having proper buildings, in ſo far as they reſpect the management of the farm, but that they have likewiſe conſiderable influence in promoting the improvements of huſbandry.

* Donaldſon's Modern Agriculture, vol. II. p. 42.

SECTION III.

Farm-Cottages.

COTTAGES—Building of, important to Agriculture—Promotes the Intereſt of the Farmer and Land Proprietor—Advantages of, as explained by different Writers—The Aſſiſtance of Cottagers neceſſary to the Farmer—The Utility of connecting ſuch Buildings with Farms—Uſeful in other Points of View—Moſt expert Labourers in Huſbandry produced by this Means—Without them much Time frequently loſt—Farmers often injured—Advantageous to have many on Farms—May ſometimes be beneficial for Tenants to build, or aſſiſt in building them—Condition of Labourers thus much benefited—Their Habits rendered more regular—More diſpoſed to perform the Buſineſs of Cultivation—Neceſſary to remove all Obſtacles to the Erection of—They promote Population—Uſeful for the Farmer to be more intimately connected with Cottagers—Proper Regulations ſhould exiſt between them—Advantages of ſuch a Mode—Should have Portions of Land annexed to them—Utility of ſuch a Plan—How it may be effected—Different Situation of Labourers conſidered—Earl of Winchelſea's Obſervations on them—Difference of Cottagers that have Land, and thoſe that have not—Neceſſity of improving their Cottages, ſhewn—Certain Regulations neceſſary when Land is annexed to them—Should be held in the Poſſeſſion of the Proprietors—When held by the Farmer injurious to the Cottager—Conſtruction of different, according to Circumſtances and Purpoſes—For the farming Labourer, Plainneſs, Simplicity, and Convenience, only neceſſary—The miſerable Hovels they ſometimes inhabit, highly diſguſting—Situation of, little attended to—Should be rather elevated, not high—Should be near the Farm—Circumſtances to be attended to in the Ground Floors of—In other Parts of—Size of various—Modes of dividing the Rooms in different Inſtances—Economical Modes of placing the Stairs—Mr. Kent's Opinion of their Accommodations—Beſt Forms of—Circular Plan objectionable—Building two or more together ſaves Expence.—Upper Rooms neceſſary for the Preſervation of Health—Attention to Warmth neceſſary in Conſtruction of—Conveniences for free Circulation of Air, uſeful—Means of preventing exceſſive Heat in Summer—Cheap Methods of covering them—Thatch—Reed—Stubble—Pitched Paper, mentioned by Mr. Bateſon—Circumſtance to be regarded in Materials for Building with—Should always be White-waſhed in ſuch Caſes—Methods of proceeding where earthy Subſtances are employed—Manner of laying the Floors—Materials proper for—Reaſons why Plaſter is uſeful—Saving of Fuel to be attended to in Conſtruction of—Means of accompliſhing—Builders ſhould attend more to Philoſophical Principles—Particulars to be regarded in Reſpect to Water in—Mr. Holland's Opinion of—Various Advantages of Sheds, and

Privies in—Expences of, vary according to Circumſtances—Different Eſtimates of—Of double Brick Cottages—Of ſingle ones—Of Stud and Mud ones—Particulars in the Management of—Different Obſervations on.

HOWEVER much the building and providing of ſuitable accommodations for farming labourers may have been neglected or unattended to, it is evidently a ſubject of conſiderable intereſt to agriculture, and upon which, perhaps, much of its ſucceſs and improvement depends. It has been well obſerved by an able writer, that without hands, for the purpoſe of cultivation, eſtates are of no value; conſequently, the farming labourer is one of the moſt important members of ſociety: without his aſſiſtance the beſt and moſt fruitful ſoil is not worth poſſeſſing; his condition ſhould, therefore, if it were only out of good policy, be rendered more eaſy andcomfortable. If no other motive ſhould operate in the promotion of this purpoſe, the intereſt of the farmer and land proprietor of every deſcription evidently, he thinks, demands it*.

The advantages of letting perſons of this claſs comfortable cottages with gardens, and ſmall plots of graſs land adjoining them, as far as it reſpects themſelves, have lately been well explained by the judicious enquiries of ſeveral noble authors†. And that ſuch a plan would be equally, if not more beneficial to the farmer, there can be little doubt. For it is obvious, that though he may have a certain number of labouring people conſtantly about him, they will not be able, on every occaſion, and in every place, to perform all the buſineſs that is neceſſary on his farm. He muſt, therefore, either be under the neceſſity of keeping more ſervants than are abſolutely requiſite, at great expence, or he muſt have recourſe to the aid of the cottage labourer. This clearly proves the importance of cottages being connected with farms. But this is, however, far from being the only point of view in which it is important; it is moſtly from amongſt this claſs of men, that the beſt and moſt expert labourers in the buſineſs of huſbandry are procured; being, in general, inured from their infancy to ſuch labours, and accuſtomed to perform the different operations of farming, they are enabled to manage the practical part of agriculture with much eaſe and readineſs, which is far from being the caſe with the common labourer, who, for the moſt part, has been brought up to ſome other occupation or employment. Beſides, on ſuch farms as are at ſome diſtance from towns and villages, theſe

* Kent's Hints.

† Earl of Winchelſea, Lord Brownlow, &c. in Communications to the Board of Agriculture, vol. I.

accommodations for labourers ſeem indiſpenſably neceſſary, as without them much time muſt, of courſe, be loſt in going backwards and forwards to their different meals, and the places in which they lodge; and from the unavoidable fatigue that attends this mode, they are little diſpoſed to procure work at a diſtance, if they can poſſibly get it at the places where they reſide, which in many ſituations often reduces the farmer to much inconvenience, if not actual loſs. Where, therefore, the ſyſtem can be introduced with convenience, and a mutual intereſt be eſtabliſhed between the farmer and the labourer, it will be to the advantage of the former to have as many cottages on his farm as poſſible; and under ſome circumſtances, as in caſe of long leaſe, it may even be advantageous for him to build them, or at leaſt aſſiſt the proprietor in doing it, by the conveyance of materials, and other ſuch means as are in his power.

In this way, the condition of the labourers in agriculture would be conſiderably improved; their means of living be rendered more certain and eaſy; their habits more regular and induſtrious; and their diſpoſitions, in general, probably more favourable for the buſineſs of cultivation.

But, in order the more readily and effectually to promote and accompliſh a matter of ſo much conſequence to agriculture, every obſtacle ſhould be removed out of the way which has the leaſt tendency to retard the erection of ſuch buildings; whether ariſing from old acts of parliament made under very different circumſtances from the preſent, or parochial and other regulations of a more local nature.

It has been a remark of great antiquity, that nations are rich in proportion to their population; and ſo an able writer, on the ſubject of cottages, obſerves "it is in a great meaſure with an eſtate or a farm, for the more numerous its inhabitants, the more eaſily will it be cultivated and improved. The erection of cottages is, therefore," ſays he, "an object of great importance to the farmer, as well as to the proprietor; but it is neceſſary for the mutual advantage of both parties, that the landlord and his cottagers ſhould be on the beſt of terms; that he ſhould regard them as part of his own family, and that they ſhould look up to him as their beſt and ſureſt friend and protector. Every cottager ſhould, therefore, conſider, that in promoting the intereſts of his landlord, whether proprietor or tenant of the farm, he is at the ſame time promoting his own; for a landlord has it much in his power to ſerve and oblige his cottagers in various ways, as they themſelves muſt be ſenſible of*."

* Beatſon in Communications to the Board of Agriculture, vol. I.

With a view to render the building of habitations for the labourers in huſbandry, not only more agreeable, but more advantageous to the different parties; it would, perhaps, in many caſes, be uſeful to have ſuitable conditions ſtipulated between them, by which the landholder ſhould be ſecured for the labour of his tenant, when neceſſary, upon fair and equitable terms, while the labourer is made certain of his reſidence, on the due performance of them. In regard to payment of rent, on ſome occaſions, it would, likewiſe, be extremely proper and convenient to have ſuch regulations as would ſecure its diſcharge in the moſt eaſy and leaſt oppreſſive manner. By adopting ſome ſuch plan as this, many diſagreeable diſputes, and much uneaſineſs, would frequently be prevented, and at the ſame time the cottager be enabled to perform his engagements with greater exactneſs, and far more comfort to himſelf.

That cottages, wherever it can poſſibly be done, ought conſtantly to have ſome portions of land annexed to them, ſeems generally allowed; but the mode of attaching it, and the quantity which is requiſite in different caſes, are matters of conſiderable difficulty, and which muſt, probably, depend on various local circumſtances, ſuch as the abundance or ſcarcity of land, the manner in which it is cultivated, and the diſpoſitions of the occupiers. In every ſituation, perhaps, a ſufficient quantity for the growing of proper vegetables for the cottager and his family may be ſpared, as for this purpoſe not more than twenty or thirty perches of ground will be required. It is, however, notwithſtanding this, well obſerved by the Earl of Winchelſea, in the valuable paper which we have already quoted, that the beſt ſituation for a labourer is that of his holding a ſufficient quantity of graſs incloſed land, for the keeping of one or more cows winter and ſummer, with a garden contiguous to the houſe; as in this caſe all the buſineſs is done by his wife, except that of making hay, and he is not taken off from his labour. This kind of allotment can, however, evidently only be made where graſs land is abundant.

The next ſituation in point of advantage, he conceives to be that in which the cottager has a ſummer paſture for his cow, and a portion of arable land upon which the winter proviſions are grown. In this caſe it is, however, obvious that too much of the labourer's time muſt generally be taken up by the management of his arable ground. Where, indeed, a part is ſown with artificial graſſes, it may not be ſo employed to any hurtful degree. On his lordſhip's eſtates this plan is found to anſwer very well. It is evident that this mode of diſtribution muſt be very narrow and confined in its operation, as it can only be had recourſe to in caſes where there is a mixture of arable and paſture grounds.

The third ſituation in reſpect to the benefit of the farming labourer, is that in which he has a right of common for the ſummer keep of his cow, and a meadow or arable land; or a meadow in common for the providing of winter food.

This, his lordſhip conceives, would be nearly equal to the two former, were it not that commons are ſo frequently overſtocked as to render the ſummer keep extremely bad; this is of courſe a great loſs, and if the meadow be in common too, the matter is ſtill worſe. He further remarks, that, "it is certain that upon an incloſure, if the owners chooſe it, the labourers who keep cows may be placed in a much better ſituation than they were, in as much as incloſed land is more valuable to occupiers of every deſcription, than commons and open fields. Garden ground may alſo be allotted to them and others, which cannot be done while the land remains unincloſed. I am perſuaded, continues he, that where theſe things are attended to, very few objections to an incloſure will ariſe on the part of the labourers, and that the land-owners will have the ſatisfaction of benefiting the poor, and at the ſame time of making their own property more valuable, by adopting, what, in all probability, will be the means of keeping down the poors' rate."

In theſe ſituations, gardens are always ſuppoſed to be near the houſe; but where they have more, or where the ground lies at ſome diſtance from them, the advantages cannot, by any means, be ſo great.

The fourth ſituation is that in which the labourer has a right of common, and a garden. This is highly beneficial, his lordſhip ſuppoſes, as geeſe and pigs may be kept upon the common paſture, and the latter be fed by means of the garden ſtuff, and a ſmall quantity of other food which can be eaſily procured by the cottager.

The fifth caſe is that in which the labourer has a right of common, but without a garden. This, he thinks, is obviouſly of little utility to him, unleſs in ſituations where fuel can be procured from it, in which caſe it becomes extremely valuable, and the loſs of which cannot be eaſily repaired.

The ſixth is that ſituation in which the labourer has ſome arable ground, but without any ſummer paſturage for his cow. This his lordſhip conſiders as of little uſe; for, ſays he, "though he may cultivate part of the land as a garden, the continued labour it would require to ſtall-feed a cow winter and ſummer, and the quantity of land he muſt till, would occupy ſo much of his time, that the *take* would, upon the whole, be injurious to him, even ſuppoſing the land incloſed,

and contiguous to his houſe; and if at a diſtance, or not incloſed, the diſadvantage would be ſtill greater.

The ſeventh ſituation of the cottage labourer is that in which he has merely a garden adjoining his habitation. This his lordſhip conſiders as the beſt thing that can be done for labourers in arable countries; as lands cultivated in this way afford a much greater quantity of food for man, than when managed in any other manner. Beſides, the greateſt part of the work is done at ſuch times as the labourer and his family can conveniently ſpare from their more particular employments.

The laſt, and by much the worſt, ſituation, is that in which the labourer has no land whatever. Under this circumſtance he cannot, his lordſhip thinks, be ſo comfortable to himſelf, or have the means of making his children acquainted with that kind of labour and knowledge which is eſſentially neceſſary for them. "When a labourer is poſſeſſed of cattle," ſays the able author of the paper we have before mentioned, "his children are taught early in life the neceſſity of taking care of them, and acquire ſome knowledge of their treatment; and if he has a garden, they learn to dig and weed, and their time is employed in uſeful induſtry, by which means they are more likely to acquire honeſt and induſtrious habits, than thoſe who are bred up in the poverty and lazineſs we too often ſee; for I believe," continues he, "it is a certain fact, that extreme poverty begets idleneſs."

Theſe intereſting obſervations clearly ſhew that on ſuch grounds there cannot be any doubt of the advantages of farming labourers poſſeſſing ſmall portions of land, or at leaſt gardens. It is a ſyſtem which tends not only to benefit them, but which, at the ſame time, muſt greatly contribute to the intereſt of the owners of land, and the community in general. Such a plan cannot, indeed, from various local cauſes, be generally introduced, but it may be rendered much more common and extenſive than it is at preſent, ſince the narrow, confined, and illiberal notions, which have ſo long retarded its execution, have now been fully ſhewn to be erroneous and ill founded. It is well obſerved by the noble author we have ſo frequently mentioned, that, "in countries where it has never been the cuſtom for labourers to keep cows, it would be very difficult to introduce it; but where no gardens have been annexed to the cottages, it is ſufficient to give the ground, and the labourer is ſure to know what to do with it, and will reap an immediate benefit from it."

The advantages of gardens are alſo great, in reſpect to the labourers themſelves, as the attention they require prevents them from viſiting the ale-houſes. The

Rev. Mr. Townſend has ſomewhere well remarked, that " there is a ſtriking difference between the cottagers who have a garden adjoining their habitations, and thoſe who have no garden. The former," ſays he, " are generally ſober, induſtrious, and healthy, whilſt the latter are too often drunken, lazy, vicious, and frequently diſeaſed."

When lands are let to labourers, it would ſeem to be not only juſt, but advantageous, that they ſhould never be charged higher than the price at which the farmer has them; and that the cottages themſelves ſhould always be kept at the diſpoſal of the proprietor, and not be ſuffered to paſs into the hands of the tenants or holders of farms, as is too commonly the cuſtom, frequently to the injury and diſadvantage of the cottager.

Cottages may be conſtructed in different forms, according to the purpoſes for which they are deſigned, and the intentions of the builder; but in ſuch as are merely intended for the farming labourer, all, perhaps, that is required is, that they be plain, ſimple, neat, and convenient.

It has been remarked by an accurate obſerver, that " the ſhattered hovels which half the poor of the kingdom are obliged to put up with, are truly affecting to a heart fraught with humanity. Thoſe who condeſcend to viſit theſe miſerable tenements, can teſtify," he ſays, " that neither health nor decency can be preſerved in them. The weather frequently penetrates all parts of them; which muſt occaſion illneſs of various kinds, particularly agues; which more frequently viſit the children of cottagers than any others, and early ſhake their conſtitutions. And it is ſhocking that a man, his wife, and half a dozen children, ſhould be obliged to lie all in one room together; and more ſo, that the wife ſhould have no more private place to be brought to bed in. This deſcription," ſays he, " is not exaggerated, offenſive as it may appear. We are all careful of our horſes, nay of our dogs, which are leſs valuable animals; we beſtow conſiderable attention upon our ſtables and kennels; but we are apt to look upon cottages as incumbrances, and clogs to our property; when, in fact, thoſe who occupy them are the very nerves and ſinews of agriculture." Nay, he is bold to aver, that more real advantages flow from cottages, than from any other ſource; for, beſides their great utility to landed property, they are the greateſt ſupport to the ſtate, as being the moſt prolific cradles of population. He does not, however, wiſh to ſee the cottage improved, or augmented ſo as to make it fine, or expenſive; no matter how plain it is, he thinks, provided it be tight and convenient*.

* Kent's Hints.

The local ſituation of this ſort of cottage ſeems, in general, to have been too little attended to; it ſhould, however, be a dry, open, and rather elevated place, though by no means high, ſuch ſituations having many diſadvantages, with but few conveniences. Rather low ſituations, provided they be perfectly dry, and free from damp, are, perhaps, always to be preferred, as they poſſeſs many advantages over the other. And in every caſe they ſhould be built as near as poſſible to the farm on which the labourers who are to inhabit them are to be employed. The moſt ſuitable aſpects for the front, are the different points of the compaſs from the ſouth-eaſt round to the north-weſt. Under ſuch circumſtances as theſe, cottages, in general, need not be elevated more than one or two ſmall ſteps above the ſurface of the ground. But the ground floors of ſuch cottages ſhould not, in any inſtance whatever, be ſuffered to be lower than the ſurface of the ſituation on which they are erected, as, where the contrary is the caſe, the health of the inhabitants muſt conſtantly be in danger. The ſoil of the ſurrounding land ſhould likewiſe, if poſſible, be ſuch as that it may be advantageouſly cultivated as a garden, when converted to ſuch a purpoſe.

The ſize and internal arrangement of this ſort of building muſt of courſe be various, according to circumſtances, but in general four diviſions or rooms are ſufficient, two of which muſt be on the ground-floor, and the other two over them; the ground diviſions may occupy a ſquare of about ten or twelve feet. That into which the door opens, as it will be cold in the winter ſeaſon, may be divided and fitted up in ſuch a manner as to ſuit many convenient purpoſes in the way of ſtore-room. And by this means the common room will be kept much warmer than where the outſide door opens immediately into it*.

Where the family is large, the upper part may alſo be partitioned into a greater number of lodging-rooms, attention being always had to convenience and decency. In many caſes too, theſe points may be more fully accompliſhed by a particular arrangement of the beds; one being placed over the other, with different ways of entering into them, in the manner which we have already deſcribed, in ſpeaking of the accommodations of farming ſervants. Where this plan is adopted, the ſleeping-places ſhould always be made as eaſy of ventilation as poſſible.

As the ſcite of the farming cottage muſt of neceſſity be ſmall, it is of great conſequence to make the ſtairs and other internal parts take up as little room as poſſible. With this intention, different kinds of ſtaircaſes have been

* Young's View of the Agriculture of the County of Lincoln.

propoſed, which may be ſeen by conſulting the different plans contained in the annexed plates. In ſome caſes a ſort of ladder is conveniently adopted; and where two cottages are built together, room may be gained by reverſing the ſtaircaſes. It is, however, conceived by a writer, who ſeems to have attended much to the ſubject, that all that is requiſite in ſuch buildings is "a warm, comfortable, plain room, for the poor inhabitants to eat their morſel in; an oven to bake their bread; a little receptacle for their ſmall-beer and proviſion; and two wholeſome lodging apartments, one for the man and his wife, and another for his children. It would, perhaps, be decent, if the boys and girls could be ſeparated; but this would, he thinks, make the building too expenſive, and, beſides, is not ſo materially neceſſary, as the boys find employment in farm-houſes at an early age*."

Much has been ſaid reſpecting the forms of buildings of this deſcription; but the ſquare form, where no particular object is in view, though, perhaps, the moſt ancient, ſeems to be that which affords the moſt conveniences. The circular plan has, however, been lately recommended as being more cheap in its conſtruction, eſpecially when all formed of brick, and more eaſily erected †. This is, however, obviouſly a method that does not admit of ſo much convenience in the rooms, or of ſheds being ſo eaſily erected againſt the cottage on the outſide, which is frequently neceſſary to be done. Beſide, as they muſt of neceſſity ſtand alone, it is doubtful whether they can be built in ſo cheap a manner; and from the conical ſhape of the roof, where upper rooms are made, they muſt be more low and confined, and not, probably, permit the articles of furniture to be placed with ſo much convenience in them.

Where expence is to be ſaved, it is always the beſt method to build two or more cottages together, and to let them have upper as well as ground apartments. The health of the cottager and his family will, by this means, be better preſerved, as it is unqueſtionably more conducive to health to ſleep up ſtairs than on ground floors.

Attention ſhould likewiſe be particularly paid in theſe buildings to the rendering of them warm in winter, and cool in the ſummer. In this view, the walls and coverings ſhould not be too thin. Where the roof is covered with tile or ſlate, which is by far the neateſt and moſt durable, though by no means ſo capable of reſiſting the coldneſs of winter or heat of ſummer as thatch, the ceilings ought to be lathed and plaſtered, having ſlides ſo conſtructed as to form air-holes, by

* Kent's Hints. † Sir John Sinclair on Cottages.

which the rooms, as well as roof, may be cooled by the free circulation of air in hot weather. If the roofs of cottages were painted, or covered over with ſome white ſubſtance which would not eaſily waſh off, it would, perhaps, tend greatly to prevent their being ſo much heated in the ſummer. Of the different ſubſtances employed for the covering of the roofs of cottages, thatch is undoubtedly the cheapeſt; and the beſt kind of thatch is, perhaps, that which is prepared from a ſtrong ſort of reed found in ſome of the midland diſtricts. I have been aſſured by a perſon of much information on the ſubject, that wheat ſtubble does excellently well for thatching cottages. He has known a coat of this material laſt thirty years without any repairing.

Where wheat-ſtraw is made uſe of, it ought to be as little bruiſed as poſſible, the corn being laſhed out, a mode which is common in moſt of the northern counties. Mr. Beatſon* ſpeaks of a well-pitched brown paper, as forming an excellent light roof; and remarks, "that, in the town of Dunfermlin, in the county of Fife, there is a church with a roof of this kind which has laſted near fifty years with very little repair, excepting a new coat of tar every ſix or ſeven years. This church is ſeventy feet long, and fifty feet wide, without any intermediate ſupport for the roof, of which the whole original expence of papering and tarring amounted only to fourteen pounds."

In regard to the materials for building cottages with, thoſe will in general be found the leaſt expenſive that are neareſt the places where they are to be erected. Stone is a very good and ſubſtantial material, and frequently much cheaper than brick; but good cottages may be built with many other ſubſtances more cheaply than with either of them; ſuch, for inſtance, as different compoſitions of well-tempered earths. Theſe, when well prepared, will ſtand a long time. Moſt of the ſtrong loamy ſorts of ſoil are found to anſwer theſe purpoſes; but where there is much ſand, clay muſt be mixed with the earth until it has the proper degree of tenacity and conſiſtence. Clay alone is not, however, ſuitable for this purpoſe, as it cannot be rammed ſufficiently hard, and is of courſe liable to crack in drying. Earthy compoſitions for this uſe ſhould always be capable of being cloſely united by means of a heavy rammer made of caſt-iron, as without this they have not ſufficient ſtability.

A cheaper method is frequently followed, which is that of forming the walls of mire and ſtraw well trodden together, and laid on in layers to the proper height; and ſometimes a footing of ſtone or brick-wall is made about two feet in height, on which is placed a cill of ſtrong timber, with upright

* Communications to the Board of Agriculture.

quarterings at the diſtance of two feet, between which rounds of coarſe wood are placed croſſwiſe at the diſtance of five or ſix inches from each other, until the proper height; the ſpaces between the rounds are then filled with the compoſition of mire and ſtraw, and the whole plaſtered with good mortar, which ſhould afterwards be well rough-caſted over: it adds alſo conſiderably to their neatneſs and general effect on the eye of the traveller, if they be well white-waſhed, a cuſtom which is very prevalent in ſome parts of Wales, and which is annually performed at a very trifling expence. In ſome places, too, a ſort of rough-ſtone maſonry is employed in theſe buildings, either alone, or ſtuccoed over; but this is in general a too expenſive method.

In other places another method is followed in building the walls: a ſtrong earth, ſuch as is proper for making bricks, is formed into walls of a ſuitable height and thickneſs; after which they are left for ſome time to dry, when different ſorts of light combuſtible matters are placed round them, both on the in and out-ſide, and ſet on fire, by which means they are burnt into a kind of ſolid brick. The doors and windows are made afterwards by cutting them out of the ſolid walls, and the chimneys are built up with any ſuitable materials. We have been informed by a very attentive obſerver, that the beſt walls of the earthy kind, either for cottages or other outer walls, that he has ſeen, have been built of the mire or earthy materials ſcraped up from a turnpike or other road, after being well pulveriſed by the trituration of carriages or other means.

But of whatever materials the cottage may be built, it ſhould be made ſtrong and well put together. If of ſtone, the walls ſhould not be leſs than ſixteen inches thick; and when of brick, not leſs than one brick and an half. The mortar that is employed ought to be well tempered, and mixed together without an improper ſparing of lime. The timber ſhould likewiſe be well ſeaſoned, as green timber ſoon decays, and, from its ſhrinking, frequently produces cracks in the other materials.

The flooring for the lower rooms at leaſt may either be of earth properly prepared, or they may be laid with paving tiles or bricks. The upper floors are probably the beſt when laid with good boards of a ſtrong and durable kind; or they may be made, as we have already obſerved, of plaſter, which is a good ſubſtance for ſuch purpoſes, on account of its cheapneſs, and the little danger there is of fire, as well as its being in ſome degree more retentive of heat. Bricks, however, in the opinion of ſome perſons who have been much engaged in the erection of buildings of this ſort, ſhould conſtantly be recommended both for lower and upper floors as well as for the ſtairs.

In conſtructing of cottages, care ſhould always be taken to ſave fuel as much as poſſible, as it is a heavy expence to the labourer to be under the neceſſity of having different fires; the heat from his common fire ſhould therefore not be ſuffered to eſcape without being applied to ſome further purpoſe in the economy of his cottage, which may often be readily done by different judicious contrivances. The upper apartments might, perhaps, be in ſome meaſure warmed by means of proper flues being placed in the vents, where they paſs through them; and by making the chimneys in theſe places themſelves as thin as poſſible, or of thin materials, and ſuch as readily tranſmit heat, as plate-iron, &c. On this ſubject Mr. Beatſon ingeniouſly obſerves, that "in all apartments kept warm by a fire, it will be found that the air at the ceiling is conſiderably warmer than the air below. If therefore," ſays he, "in a cottage that warm air is permitted to aſcend to the apartment above, it is natural to ſuppoſe it will render that apartment conſiderably warmer*." This, he thinks, may be accompliſhed either by ſliding-hatches, or by gratings, in the leaſt-frequented parts of the floor, made ſo as to open or ſhut eaſily when required. When ovens are requiſite, they ought to be ſo ſituated and contrived as that the heat which is diſſipated from them may be thrown as much as poſſible into the rooms and apartments of the cottage. When the fire is not placed on the hearth, the heat might probably be made to warm the rooms or apartments more effectually, by having the grate ſo contrived as to come conſiderably forwards in the middle, ſomewhat on the plan propoſed by the ingenious Count Rumford. Such a grate might be made at little expence, and be equally convenient for every purpoſe of the cottager. But the methods of rendering the upper rooms of cottages warm or cold, according to the particular ſeaſon of the year, and by little expence or trouble, have yet been but ſlightly attended to, though they may undoubtedly be attempted with great ſucceſs and advantage in many inſtances. A due attention to philoſophical and chemical principles might, indeed, lead the builder to numerous intereſting improvements, both in regard to the convenience and the healthineſs of dwellings of every kind.

Another circumſtance of the utmoſt importance to the cottager is, that of having near him good ſoft water; it is, therefore, of great advantage in the ſituation of cottages to be near a running ſtream of water, or where there is a ſpring of ſoft water. When it is neceſſary to collect and preſerve rain-water in covered tanks or ciſterns, the water ſhould be drawn up by means of a bucket,

* Communications to the Board of Agriculture.

or ſome veſſel of a ſimilar kind, in order to prevent waſte. It is obſerved by Mr. Holland, that "a tank, ten feet in diameter, and ten feet deep, arched over, would, at an eaſy expence, ſupply twenty cottages all the year round*."

Cottages, in order to render them clean and decent, ſhould conſtantly be provided with ſmall ſheds; ſome parts of which may be employed as the repoſitories of different ſorts of implements, coals, wood, &c. and others be made uſe of as a ſort of pantries; but, above all, proper privies ſhould be conſtructed, as being not only advantageous in point of decency and cleanlineſs, but highly conducive to health, by conveying away all noxious putrid effluvia.

The expence of building cottages muſt vary according to ſituation, the quantity and expence of labour, the nature of, and eaſe with which materials can be procured, and many other circumſtances; but, in general, where no extraordinary labour or expence is required, it may be eſtimated that a good brick cottage, ſufficient for two families, will coſt from eighty to ninety pounds; and that one of the ſmaller ſort for one family not leſs than fifty; if built with ſtud and mud, they may, however, come conſiderably cheaper, as from twenty-five to thirty pounds each.

In making calculations or eſtimates for the building of cottages of this ſort, attention muſt, therefore, always be paid to the nature of the plan, and the materials with which they are conſtructed, as well as the rates at which they can be procured; it is, however, remarked, on the authority of experience, by an intelligent writer, that in thoſe parts of the kingdom even where materials and workmanſhip are the cheapeſt, ſuch cottages as are comfortable, healthy, and ſuitable for the decent country labourer, cannot be built, if they be ſingle ones, for leſs than fifty pounds, and when double, or two dwellings under one roof, for leſs than ninety pounds†, which is nearly as has been obſerved above. Where incloſures of waſte or common land are made, it will, however, frequently be neceſſary to build cottages on ſuch plans, and of ſuch ſorts of materials, as may render the expence of them conſiderably lower than the above. This may, in ſome caſes, be done by making the walls of mud, ſuch as ſoft mire and ſtraw, well incorporated together by treading with the feet, and afterwards gradually applied layer upon layer to the height which may be neceſſary. This mode of building is common in the weſtern diſtricts, and is probably the cheapeſt of any. According to Mr. Crocker, a cottage formed of this kind of

* Communications to the Board of Agriculture.

† Davis in Letters and Papers of the Bath Agricultural Society.

materials, may be erected for the trifling expence of twenty-ſeven pounds. And that where ſtones are ſcarce, others with footings of ſtone-wall for a ſtrong cill of timber to reſt upon, with upright quarterings at the diſtance of two feet, having rounds of rough wood in the manner of ladder-work, ſix or ſeven inches apart, to the proper height, the intervals between being well filled with well-wrought ſtraw and mire, or what in ſome places is termed *cab dab*, and the whole plaſtered over with good mortar, and rough caſted, may be conſtructed for fifty-eight pounds*.

Mr. Kent has given different uſeful plans and eſtimates for the building of cottages of various kinds; but when erected in the cheapeſt method, which, as has been already obſerved, is that of two of them being built together, ſtand higher than the above.

BRICK COTTAGES.

For two cottages of this kind, of the ſmalleſt ſize, his eſtimate is this:—

Bricklayers' Work.

	£.	s.	d.
The walls 166 ſquare, at 4*s.* 6*d.* per ſquare -	37	7	0
Pan-tiling, with ſmall-ſized deal lath, and ſparkled within ſide, ten ſquare and a half, at 1*s.* 2*d.* per ſquare -	11	11	0
Partitions lathed and plaſtered, on each ſide, with two coats of mortar, 107 yards, at 10*d.* per yard - -	4	9	0
Plaſtering the walls, 144 yards, at 6*d.* per yard -	3	12	0
Paving with white bricks, 125 yards, at 1*s.* 4*d.* per yard	8	6	8
Ceiling, between the joiſts, 125 yards, at 6*d.* per yard	3	2	6
Two ground-floor chimneys, and two fire-places in the chambers, and two ovens and oven-lids - - -	9	2	0
Foot-lacing in the chambers . - - -	1	1	0
Two flag-ſtones, for the chamber chimneys -	0	4	0
Carried forward -			£.78 15 2

* Communications to the Board of Agriculture, vol. I.

			£.	s.	d.
Brought over	-		78	15	2

Glaziers' Work.

			£.	s.	d.
Sixty-nine feet of glaſs, at 8*d.* per foot	-	-	2	6	0
Flaſhings of lead for the roof-windows	-	-	0	10	0
					2 16 0

Smiths' Work.

Two large caſements, at 6*s.* 6*d.* each	-	-		0	13	0
Four ſmall ditto, at 4*s.* each	-	-	-	0	16	0
Chimney-irons to hang pots on	-	-	-	0	7	6
Two ſtoves for chamber fire-places		-	-	0	13	0
						2 9 6

Carpenters' Work.

Four tons of pollard timber, at 1*l.* per ton			-	4	0	0
Five tons of deal timber, at 2*l.* 5*s.* per ton			-	11	5	0
Nine ſquare and forty feet of roofing, at 9*s.* per ſquare				4	4	6
Six ſquare and an half of flooring joiſts, at 7*s.* 6*d.* per ſquare				2	8	0
Six ſquare of flooring, with white-wood deal, at 18*s.* per ſquare				5	8	0
Twelve pair of door-caſes, at 2*s.* a pair	-	-		1	4	0
Twelve doors, at 4*s.* each	-	-	-	2	8	0
Eight windows, at 2*s.* 6*d.* each		-	-	1	0	0
Two winding ſtaircaſes, at 1*l.* 5*s.* each			-	2	10	0
Five ſquare of ſtud-partitions, at 6*s.* 6*d.* per ſquare			-	1	12	6
Two pieces of timber to lay on the chimneys			-	0	2	0
Two roof-windows, at 6*s.* each		-	-	0	12	0
Nails, and irons, for doors	-	-	-	1	12	0
Eight window-boards, at 1*s.* each		-	-	0	8	0
Shelves and work to pantries	-	-	-	0	12	0
Carriage of materials, eſtimated at		-	-	8	0	0
Add, to make the calculation even		-	-	0	13	4
						47 19 4

The amount of the two cottages	-		£.	132	0 0
The amount of one	-	-	£.	66	0 0

STUD-WORK COTTAGES.

For two cottages of this ſort, of the ſmalleſt ſize, with brick gables, it is as follows:—

Carpenters' Work.

	£.	s.	d.	£.	s.	d.
Four tons of pollard timber, at 1*l.* per ton -				4	0	0
Five tons of deal timber, at 2*l.* 5*s.* per ton -				11	5	0
Eight ſquare and fifty feet of ſtud-work, on the ſides, at 10*s.* per ſquare - - - -				4	5	0
Nine ſquare and forty feet of roofing, at 9*s.* per ſquare				4	4	6
Six ſquare and an half of flooring joiſts, at 7*s.* 6*d.* per ſquare				2	8	0
Six ſquare of flooring, with white-wood deals, at 18*s.*				5	8	0
Twelve pair of door-caſes, at 2*s.* a-pair - -				1	4	0
Twelve doors, at 4*s.* each - - -				2	8	0
Eight windows, at 2*s.* 6*d.* each - -				1	0	0
Two pair of ſtairs, at 1*l.* 5*s.* each - -				2	10	0
Five ſquare of ſtud-partitions, at 6*s.* 6*d.* per ſquare -				1	12	6
Two pieces of timber to lay on the chimneys -				0	2	0
Two roof-windows, at 6*s.* each - -				0	12	0
Nails, and irons, for the doors - -				1	12	0
Eight window-boards, and ſhelves and work to pantries				1	0	0
						43 11 0

Smiths' Work.

Two large caſements, at 6*s.* 6*d.* each - -				0	13	0
Four ſmall ditto, at 4*s.* each - - -				0	16	0
Four chimney-irons to hang pots on - -				0	7	6
Two ſtoves for chamber fire-places - -				0	13	0
						2 9 6

Glaziers' Work.

Sixty-nine feet of glaſs, at 8*d.* per foot - -				2	6	0
Flaſhings of lead for the roof-windows - -				0	10	0
						2 16 0
Carr ied forward						£. 4816 6

	£.	s.	d.
Brought over -	48	16	6

Bricklayers' Work.

	£.	s.	d.
Forty-four yards of 14-inch wall, at 4*s.* 6*d.* per yard	9	18	0
Two flag-ſtones for the chamber chimneys -	0	4	0
Two ground-floor chimneys, and two fire-places in the chambers, and two ovens and oven-lids - -	9	2	0
Outſide lathing and plaſtering, 94 yards, at 1*s.* per yard	4	14	0
Twenty-five yards of foundation, nine inches, at 3*s.*	3	15	0
Pan-tiling, with ſmall-ſized deal lath, and ſparkled withinſide, ten ſquare and an half, at 1*l.* 2*s.* per ſquare -	11	11	0
Partitions lathed and plaſtered on each ſide, with two coats of mortar, 107 yards, at 10*d.* per yard -	4	9	2
Ceiling between the joiſts, 125 yards, at 6*d.* per yard -	3	2	6
Lathing and plaſtering the inſide of the ſtuds, 144 yards, at 6*d.* per yard - - - -	3	12	0
Paving with white bricks, 125 yards, at 1*s.* 4*d.* per yard	8	6	8
Carriage of materials, eſtimated at - -	8	0	0
Add, to make the calculation even - -	0	9	2
	67	3	6

	£.	s.	d.
Amount of theſe two cottages - - -	116	0	0
Amount of one cottage - - -	58	0	0

In erecting the larger kind of cottages where bricks are employed, ſavings of ſuch expenſive materials may be made by having the ends hipped in, and at the ſame time no more tiling will be neceſſary. And beſides, in this method, the buildings are more firmly braced together, and, conſequently, more ſecure from the effects of high winds*.

* Kent's Hints, p. 220.

FARM COTTAGES.

Fig. 1.

Fig. 2.

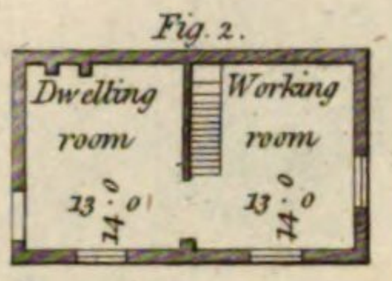


Fig. 3.

Fig. 4.

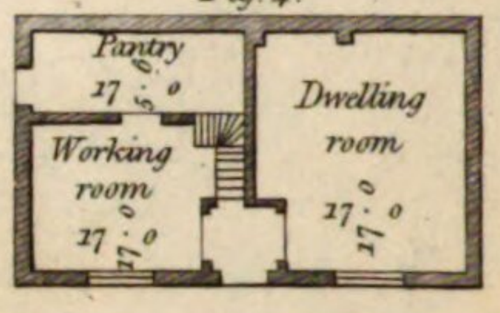


Fig. 5.

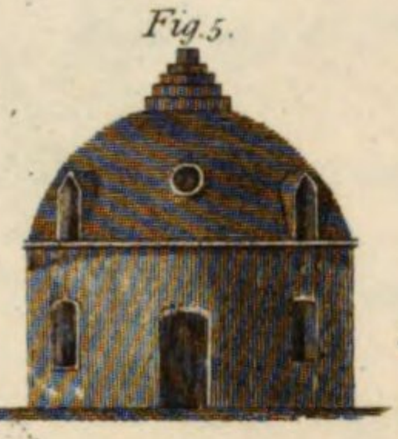


Fig. 16.

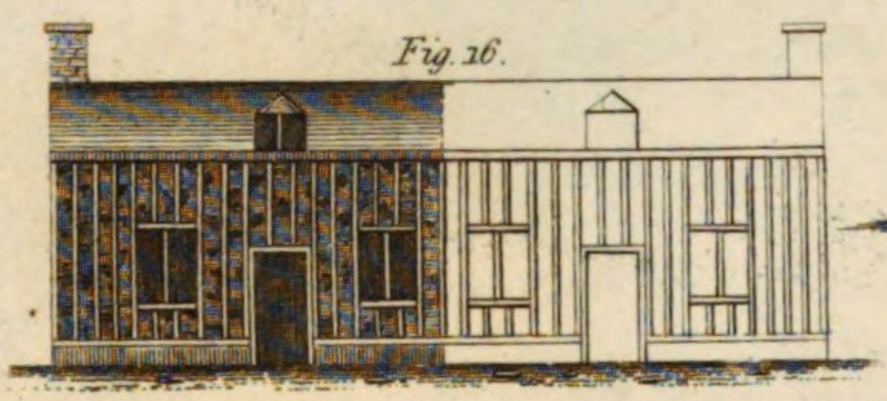


Fig. 19.

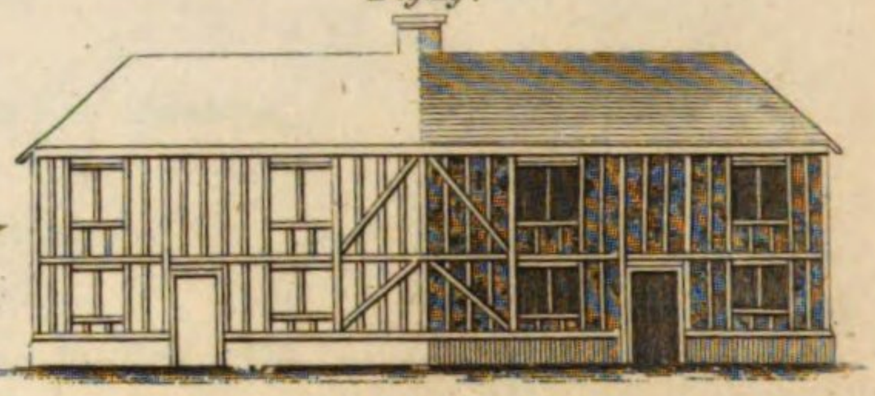


Fig. 7.

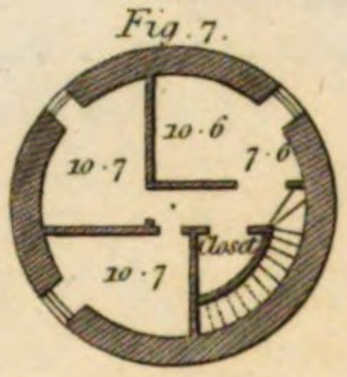


Fig. 18.

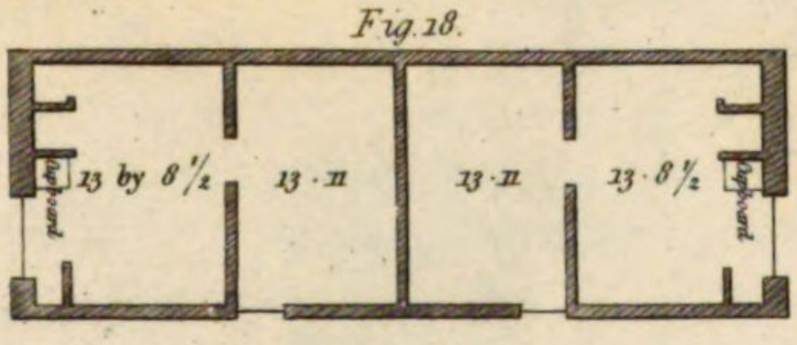


Fig. 21.

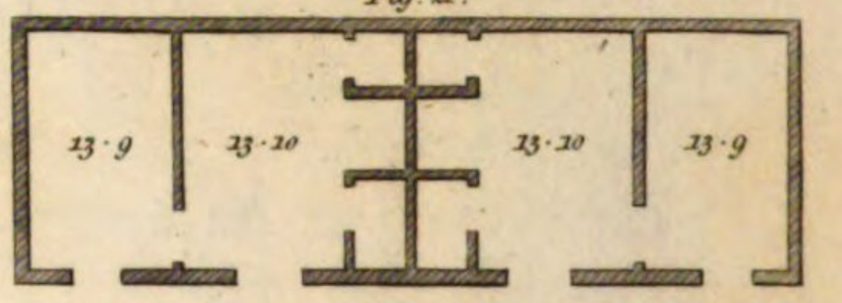


Fig. 17.

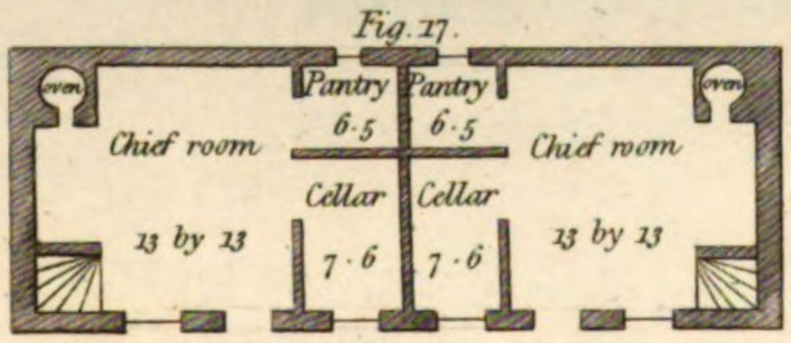


Fig. 6.

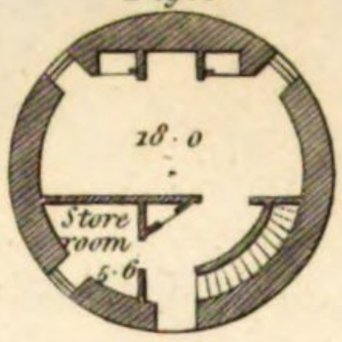


Fig. 20.

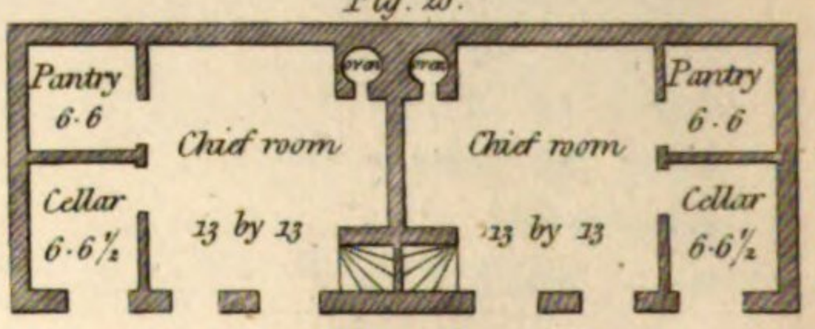


Fig. 10.

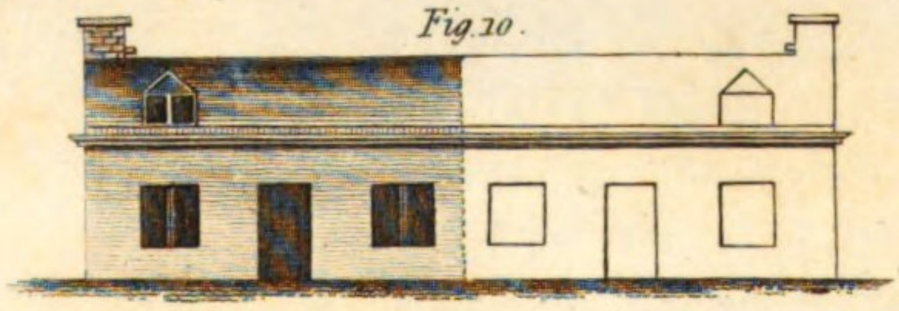


Fig. 8.

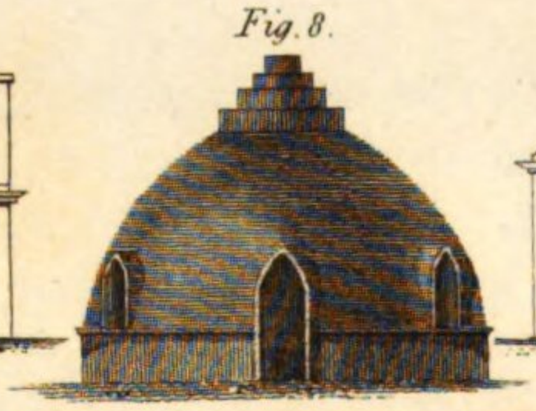


Fig. 13.

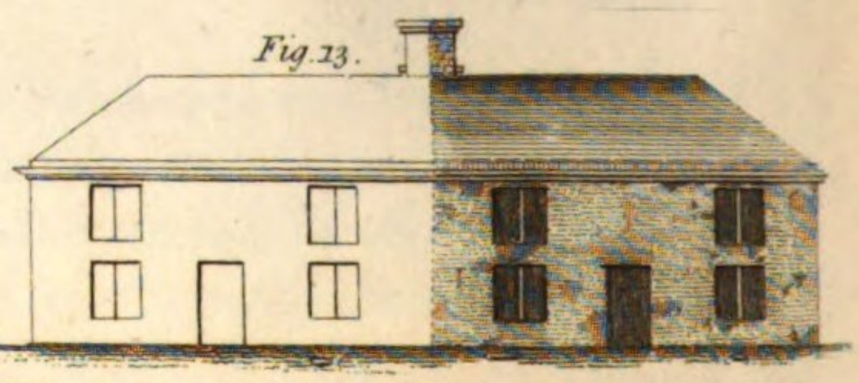


Fig. 12.

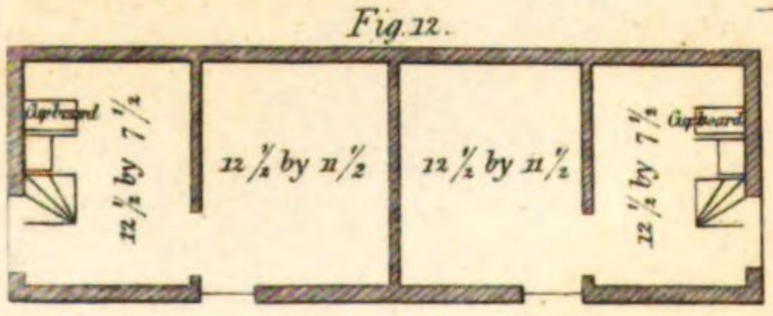


Fig. 9.

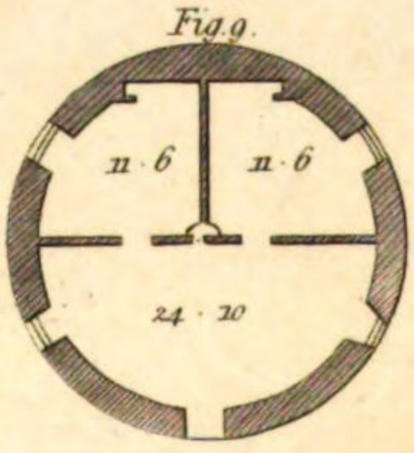


Fig. 15.

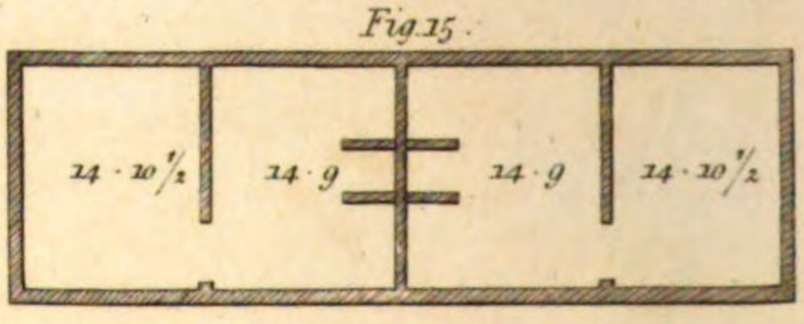


Fig. 11.

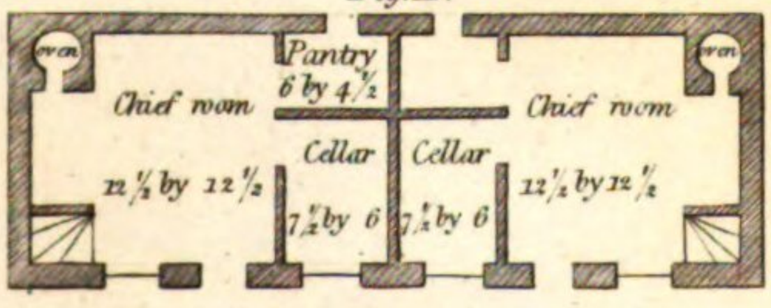


Fig. 14.

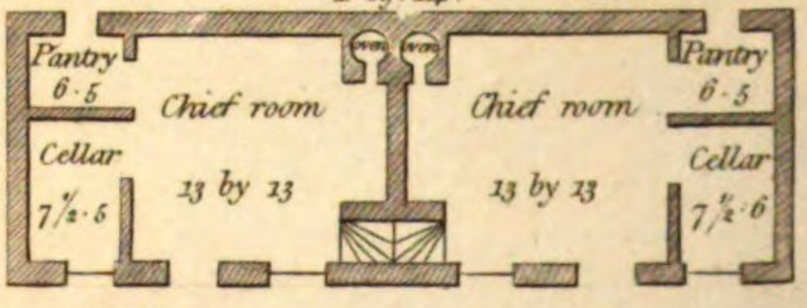


PLATE XXVIII.

Farm Cottages.

[*To face Page* 92.]

At *Fig.* 1. is repreſented a ſmall *mud-walled* cheap cottage, the chambers being lighted from the ends

Fig. 2. Is the ground plan of it.

Fig. 3. Exhibits a cheap ſort of cottage on a larger plan, built of *cub dab.*

Fig. 4. Is the ground plan of it. Theſe are the cheapeſt ſorts of cottages that can be built, and are from plans of Mr. Crocker.

Fig. 5. Repreſents a circular cottage, recommended by Sir John Sinclair.

Fig. 6. Is the ground plan of it; and *Fig.* 7. The ſecond floor.

Fig. 8. Is another cottage of the ſame ſort, but without any ſecond floor. *Fig.* 9. Is the ground plan or floor. Theſe are capable of being built wholly of brick at a ſmall expenſe.

Fig. 10. Exhibits the plan and elevation of two ſmall-ſized bricked cottages.

Fig. 11. Shows the ground plan or floor: and, *Fig.* 12. The chamber floor.

Fig. 13. Is the plan and elevation of two cottages of the ſame ſort, but of a larger ſize and with hipped ends.

Fig. 14. The ground plan or floor: and *Fig.* 15. The floor above.

Fig. 16. Is the plan and elevation of two *ſtud-work cottages*, with brick gable ends.

Fig. 17. Is the ground floor: and *Fig.* 18. The floor above.

Fig. 19. Repreſents the plan and elevation of two cottages of the ſame kind, but of a larger ſize and with hipped ends.

Fig. 20. Is the ground floor: and *Fig.* 21. The chamber floor.

Theſe cottages are recommended by Mr. Kent, as being capable of being built at a moderate expenſe, and as convenient and well adapted to farm purpoſes.

BRICK COTTAGES WITH HIPPED ENDS.

For two cottages of this ſort of the largeſt ſize:—

Bricklayers' Work.

	£.	s.	d.	£.	s.	d.
The walls, 181 yards, at 4*s.* 6*d.* per yard - -	40	14	6			
Pan-tiling, with ſmall-ſized deal lath, eleven ſquare, at 1*l.* 2*s.* per ſquare - - - -	12	2	0			
Double ſtack of chimneys, and two fire-places in the chambers, and two ovens and oven lids - -	10	2	0			
Two flag-ſtones for the chamber chimneys -	0	4	0			
Paving, with white bricks, 125 yards, at 1*s.* 4*d.* per yard	8	6	8			
Partitions lathed and plaſtered, on each ſide, at 10*d.* per yard	3	15	0			
Ceiling, between the joiſts, 125 yards, at 6*d.* per yard -	3	2	6			
Falſe ceiling, in the chambers, under the joiſts, two coats, 130 yards, at 1*s.* per yard - - -	6	10	0			
Plaſtering the walls, 169 yards, at 6*d.* per yard -	4	4	0			
				89	0	8

Glaziers' Work.

Ninety-feet of glaſs, at 8*d.* per foot - -	3	0	0			
				3	0	0

Smiths' Work.

Four large caſements, at 6*s.* 6*d.* each - -	1	6	0			
Two ſmall ditto, at 4*s.* each - - -	0	8	0			
Two ſtoves for chamber fire-places - -	0	13	0			
Chimney irons to hang pots on - -	0	7	6			
				2	14	6

Carpenters' Work.

Three tons of pollard timber, at 1*l.* per ton -	3	0	0			
Three tons and an half of deal timber, at 2*l.* 5*s.* per ton	7	17	6			
	10	17	6			
Carried forward -				£.94	15	2

	£.	s.	d.	£.	s.	d.
Brought over				94	15	2
	10	17	6			
Nine ſquare and forty feet of roofing, at 9*s.* per ſquare	4	4	6			
Five ſquare of ſtudded partitions, at 6*s.* 6*d.* - -	1	12	6			
Six ſquare and an half of flooring joiſts, at 7*s.* 6*d.* per ſquare	2	8	0			
Six ſquare of flooring, with white-wood deals, at 18*s.*	5	8	0			
Twelve pair of door-caſes, at 2*s.* a pair - -	1	4	0			
Two pieces of timber to lay on the chimneys -	0	2	0			
Twelve doors, at 4*s.* each - -	2	8	0			
Eight windows, at 2*s.* 6*d.* each - -	1	0	0			
Two pair of ſtairs, at 1*l.* 5*s.* - -	2	10	0			
Nails, and irons, for the doors - -	1	12	0			
Two pieces of timber, the whole length of the building, for lintels, to lay the joiſts on - - -	0	6	0			
Six ſquare and an half of ceiling joiſts, at 6*s.* 6*d.* per ſquare	2	2	3			
Eight window-boards, at 1*s.* each - -	0	8	0			
Shelves and work to pantries - -	0	12	0			
Carriage, eſtimated at - - -	8	0	0			
Add, to make the calculation even - -	0	10	1			
				45	4	10
Amount of the two cottages - -				£.140	0	0
Amount of one - - -				£. 70	0	0

STUD-WORK COTTAGES WITH HIPPED ENDS.

For two ſtud-work cottages, with hipped ends:—

Carpenters' Work.

	£.	s.	d.
Five tons of pollard timber, at 1*l.* per ton -	5	0	0
Six tons of deal timber, at 2*l.* 5*s.* per ton -	13	10	0
Sixteen ſquare and ſixteen feet of ſtud-work, on the ſides, at 12*s.* per ſquare - - - - -	9	13	6
Five ſquare of ſtud-partitions, at 6*s.* 6*d.* per ſquare -	1	12	6
Carried forward -	29	16	0

	£.	s.	d.
Brought up -	29	16	0
Six ſquare and an half of flooring joiſts, at 7*s.* 6*d.* per ſquare	2	8	0
Six ſquare and an half of ceiling joiſts, at 6*s.* 6*d.* per ſquare	2	2	3
Nine ſquare and forty feet of roofing, at 9*s.* per ſquare	4	4	6
Six ſquare of flooring, with white-wood deals, at 18*s.* -	5	8	0
Twelve pair of door-caſes, at 2*s.* a pair - -	1	4	0
Twelve doors, at 4*s.* each - - -	2	8	0
Eight windows, at 2*s.* each - - -	0	16	0
Two pair of ſtairs, at 1*l.* 5*s.* each - -	2	10	0
Shelves and work to pantries - -	0	12	0
Two pieces of timber to lay on the chimneys -	0	2	0
Eight window-boards - - -	0	8	0
Nails, and irons, for the doors - -	2	0	0
			53 18 9

Smiths' Work.

Four large caſements, at 6*s.* 6*d.* each -	1	6	0
Two ſmall ditto, at 4*s.* each - -	0	8	0
Two ſtoves for chamber fire-places - -	0	13	0
Four chimney-irons to hang pots on - -	0	7	6
			2 14 6

Glaziers' Work.

Ninety feet of glaſs, at 8*d.* per foot - -	3	0	0
			3 0 0

Bricklayers' Work.

Falſe ceiling, in the chambers, under the joiſts, 130 yards, at 1*s.*	6	10	0
Ceiling between the joiſts, 125 yards, at 6*d.* -	3	2	6
Forty-four yards of foundation-walls, at 3*s.* per yard -	6	12	0
Outſide lathing and plaſtering, 122 yards, at 1*s.* per yard	6	2	0
Ten ſquare and an half of tiling, at 1*l.* 2*s.* per ſquare -	11	11	0
Inſide partitions lathed and plaſtered, on both ſides -	3	15	0
Two ground-floor chimneys, and two fire-places, and two ovens and oven-lids - - -	10	2	0
	47	14	6
Carried forward -			59 13 3

				£.	s.	d.
Brought over						
				59	13	3
	£.	s.	d.			
	47	14	6			
Paving, with white bricks, 125 yards, at 1s. 4d. -	8	6	8			
Lathing and plaſtering the inſide-ſtuds, two coats of mortar, 169 yards, at 1s. per yard - -	8	9	0			
Two flag-ſtones for chamber fire-places - -	0	4	0			
Carriage of materials, eſtimated at - - -	8	0	0			
Add, to make the calculation even - -	0	12	7			
				73	6	9
Amount of theſe two cottages - -				£.133	0	0
Amount of one - - -				£. 66	10	0

In the letting or management of cottages, there are ſeveral circumſtances that require to be more attended to than ſeems in general to have been the caſe. It ſhould always be the object of the proprietors of farms to guard the labouring cottager, as much as poſſible, from being injured by any improper conduct in the common farmer, while at the ſame time his labour is effectually ſecured to the farm; and alſo, that his little rent be exacted in the moſt eaſy and convenient way. The firſt may, probably, be the moſt eaſily effected by the proprietors of lands keeping the cottages that may be upon their farms in their own hands, and not ſuffering their tenants to have the direction or management of them; and by their having juſt and equitable ſtipulations in reſpect to labour entered into between their cottagers and their tenants. The latter may be accompliſhed in various ways; but that which is practiſed in ſome of the midland diſtricts, of deducting from their wages, at the cloſe of every week, a ſmall part proportioned to the value of their labour, and the annual ſum which they pay for their cottage, in order to diſcharge their rent, ſeems the leaſt objectionable. It is obſerved by an uſeful and well-informed writer on the ſubject, that "there is another plan relative to cottages, which generally anſwers extremely well, and that is, to leaſe them off to induſtrious labourers, for the term of three lives, at their nomination; taking a very moderate fine, not exceeding ten or twelve pounds, upon a cottage worth about forty ſhillings a-year; reſerving a ſmall quit-rent, not exceeding half a crown a-year, and making it a point to renew any life which drops off, upon one year's value only." This ſcheme, he contends, is beneficial for landlord and tenant; for though the former does not let his

cottages for ſo much as he might at rack-rent, yet what he does get, is all clear money; and by this means he preſerves the value of all other parts of his eſtate, by keeping up a proper number of inhabitants. The latter, he thinks, finds his account in it, becauſe he makes a ſettlement for his family; and can repair and improve his cottage at leiſure hours with his own hands; and if he be an induſtrious man, he can generally find a friend to lend him his firſt fine, on ſuch an occaſion, if he cannot raiſe it himſelf *.

This is a plan that has been attempted with ſucceſs in different diſtricts; but it is, perhaps, better calculated for the large than the ſmall proprietor.

From what has been advanced, it muſt be ſufficiently evident that the building of proper cottages for farming labourers is not merely a matter that intereſts the proprietors of land, inſomuch as it renders the ſituation of that uſeful claſs of workmen more comfortable, but which, at the ſame time, has a great tendency to promote the full and complete cultivation of the ſoil.

* Kent's Hints, p. 217.

SECTION IV.

Incloſing of Land.

INCLOSING.—Advantages of, various—Contributes much to Improvements in Cultivation—Produce thereby greatly augmented—Utility of, in producing Warmth and Shelter—Promotes the Fattening of Animals—Value of Land much increaſed by it—Some Sorts more than others—Turnip Soils probably the moſt—Where neceſſary or not—Has not been ſufficiently attended to—Cauſes of this Neglect—Sometimes ariſes from Miſmanagement in the Direction of Incloſures—Various Circumſtances to be regarded in—Utility of certain Clauſes in Bills of Incloſure—Building Cottages neceſſary—Situation of thus improved—Methods of appointing Perſons to tranſact the Buſineſs of Incloſure—Circumſtances to be attended to in—Utility of a general Act of.—FENCES—Circumſtances to be regarded in the Making of—Particulars to be attended to in—Should be regulated by the Kind of Farm and Nature of Soil—Effects of different-ſized Incloſures—Middle-ſized generally moſt advantageous—Difference of in Graſs and Arable Land—Circumſtances to be attended to in each—Advantages of different Kinds.—WALLS—Different Kinds of, deſcribed—Advantages of each—Nature of Foundations of—Modes of making of—Liſt Walls—Dry Walls—Earth and Stone Walls, or Dikes—Method of forming them, according to Dr. Anderſon—Means of protecting them—May be made cheaply—Rendered more laſting by daſhing, lipping, and hurling with Lime—Middleton's Opinion of Walls in general—In ſome Situations moſt advantageous for a limited Time.—PAILING-FENCES—Cannot be generally adopted for Farm Incloſures—Different Kinds of, deſcribed—May often be cheaply made—Utility of, in particular Caſes—Hurdles or moveable Fences—Should be formed of light Wood—Circumſtances to be regarded in erecting Pailing-Fences—Means of preſerving them from Decay.—LIVE HEDGES—Attention to Situation and Soil neceſſary in raiſing—Kind of Ground and Situation in which different Sorts of Plants may be moſt uſefully employed—Different Advantages of the White and Black Thorn—The Willow-Alder, Furz, and Beech—Circumſtances to be regarded in uſing a Mixture of different Sorts of Plants—Neceſſary Preparation of the Land, and the Advantages of it—Proper Seaſon of planting—What neceſſary to attend to in chooſing the Plants—In raiſing them in the Nurſery—Moſt advantageous Size of—Thoſe of equal Growth ſhould be planted together—The trimming requiſite for them—Methods of planting Hedges—Vary much in different Diſtricts—On ditch Banks—On Sod turned up—On the plain Surface—Different Ways of making them—Advantages and Diſadvantages of each Mode—Methods recommended by Mr. Middleton—Utility of them—What neceſſary in planting on Banks—Diſadvantage of large

*Banks and Ditches—Where moſt uſeful—Planting on the Surface without Banks—Where proper—Means of ſheltering young Hedges—Circumſtances that prevent quick Hedges from ſucceeding—Diſadvantages of Trees in Hedge-rows—Modes of managing young live Hedges—Compariſon of, with Walls—Management of old Hedges—In different Situations—When expoſed to ſea Air.—*DITCHES*—What neceſſary in the making of them.—*GATES*—Various Modes of Conſtruction of—Kinds of Wood moſt uſeful—What neceſſary to be attended to in.—*STILES*—Beſt Methods of making them—Obſervations on Fences in general—On the Means of making, managing, and preſerving them.*

THE beneficial conſequences that neceſſarily reſult from the incloſure of land, whether in a ſtate of waſte and common, or otherwiſe, are numerous and important. In addition to thoſe of aſcertaining and ſecuring the property, it holds out, not only the moſt ready and certain means of improvement in the cultivation of the former, but in ſuch as have been long under the plough, or any other ſyſtem of management; being equally uſeful in its tendency to bring them into the moſt perfect and advantageous ſtates of culture. Without incloſing, however, much attention may have been paid, or expence incurred, in carrying on the various proceſſes that are requiſite in preparing land for the reception and growth of good crops; whether of the grain, root, or graſs kinds, it is obvious that they can neither be conducted under the moſt beneficial management, nor yield the full advantage they are capable of, while they continue in a free and open ſtate. Where the land is in a ſtate of arable cultivation, without incloſure, the crops, of whatever ſort they may be, muſt conſtantly be expoſed to depredations of various kinds; and if in the ſtate of graſs or paſture, injuries of the moſt prejudicial nature muſt frequently be unavoidably ſuſtained. The great advantage and importance of incloſing land is ſtill more fully demonſtrated in the differences which may be obſerved, in reſpect to the quantity and value of the produce, in ſuch as have been thus divided, over that which is cultivated in the ſtate of open or common field.

It is well obſerved, by an intelligent practical writer, that " in proportion as a field or a country is bleak, naked, and expoſed to chilling blaſts and winter ſtorms, in the ſame proportion will it be unproductive, compared with lands more favourably ſituated. Incloſing is a mean of obtaining, by art, a certain degree of that genial warmth ſo eſſential to the production of valuable crops, but which nature is not always pleaſed to beſtow. Every day's experience," continues he, " proves that where grounds are ſheltered from the violence of ſtorms, as by garden-walls, or by plantations of foreſt-trees, they are more pro-

ductive, and vegetation is earlier than in others ſimilar in every reſpect, unleſs in regard to expoſure. How many inſtances," ſays he, " occur to eſtabliſh this fact, in reſpect to large fields, as well as to gardens, orchards, &c. Let the obſervant farmer, who poſſeſſes an incloſed farm, examine that part of a field where, owing to the decay of the fence, the wind enjoys a free paſſage, and he will be ſatisfied of the benefit of incloſing, from the ſuperiority of the crop in the other part of the field, over that which is within the influence of this additional expoſure. While, on the other hand, the poſſeſſor of an open field farm, by examining the ſuperior verdure that takes place in any part of an open field, that is by ſome accidental circumſtances ſheltered in a remarkable degree, may ſatisfy himſelf, that were the whole equally ſheltered, the produce would be more abundant*."

And by another author, it is remarked, that " as the warmeſt air lies neareſt the ſurface of the earth, being that portion of the atmoſphere which, like a blanket, nature ſpreads over the ſoil and its productions, fences of all kinds tend more or leſs to prevent ſuch a valuable covering from being blown off by the winds†."

But, beſides theſe, there are other benefits to be derived from the judicious fencing in, or incloſing of land, proceeding from the warmth and ſhelter which it affords to cattle of various kinds. Under theſe circumſtances, animals are invariably found not only to advance in fleſh much more rapidly, but to be freer from diſorders, than when kept in ſituations that are bleak and expoſed, and which cannot afford warmth or ſhelter to them. " If," ſays the author we have firſt quoted, " any perſon entertain doubts reſpecting the incloſed paſtures being better adapted for rearing and fattening live-ſtock than open fields, he may eaſily ſatisfy himſelf, by comparing the live-ſtock in an incloſed pariſh with that of one in the open-field ſtate. He is much miſtaken," he ſays, " if he will not find them, in the latter, not only fewer in number, but each animal, on an average, thirty or forty per cent. inferior in value. In ſhort, incloſing," he thinks, " may be denominated the firſt ſtep towards effecting improvements in the breeds of the different ſpecies of live-ſtock. And on the whole, this," he conceives, " is reaſoning on plain eſtabliſhed facts, and on ſuch as afford the moſt indubitable evidence of the ſuperiority of incloſed fields, whether for tillage or paſturage. Were farther proof neceſſary, the additional rent which is every-where paid for

* Donaldſon's Modern Agriculture, vol. III. p. 302.

† Robertſon's Preſent State of Agriculture in Mid-Lothian, ſecond edition, p. 77. Note.

incloſed land, beyond that paid for land of an equal quality in the open field ſtate, is ſufficient," he thinks, " to place the matter beyond all poſſibility of doubt."

By means of incloſing, the value of the land is, in moſt ſituations, conſiderably improved. The proportion of the increaſe of value that may be made in this way, whether the incloſed lands be in a ſtate of leaſe, or in the hands of the proprietor, muſt, however, depend greatly on the nature of the ſoil, and the ſyſtem of management that is purſued. It is obſerved, that " lands of a middling quality, good turnip ſoil for inſtance, are probably benefited to a greater degree by incloſing, than thoſe of ſuperior or inferior quality. Lands of this deſcription, in the open-field ſtate, may, it is aſſerted, be conſidered as rented to the full at fifteen ſhillings the acre; whereas there are few inſtances where ſuch lands, when incloſed, are rented under twenty ſhillings; an advance ſo great as to afford the proprietor a handſome profit, after paying the intereſt of the money expended. Thus does incloſing not only increaſe the quantity and quality of the produce, ſo as to enable the farmer to pay his landlord a higher rent, and to contribute a larger ſhare to the revenues of the ſtate, but from ſo many people being conſtantly employed in making and repairing the fences, incloſing, in this view, muſt alſo be conſidered as beneficial *."

There are, however, in many diſtricts, extenſive, barren, and mountainous tracts of land, that can never be incloſed with the leaſt proſpect of advantage; or, if they could, that could never derive any amelioration from ſuch a meaſure; the only means by which they can be improved is by being rendered, in particular ſituations, more free from injurious ſurface moiſture, by proper drainage, or by the introduction of better and more perfect breeds of the ſeveral kinds of animals, which it may be neceſſary to turn upon them. In ſome other ſituations too, as where the land is capable of being cultivated almoſt conſtantly under the arable ſyſtem, incloſing, at leaſt with any kind of high fences, may be, in a great meaſure, if not wholly, unneceſſary. But, in general, where lands are cultivated under a ſyſtem of management, ſuch as that of alternating graſs or other kinds of green crops with thoſe of grain, and thereby combining improvement in the breed of live-ſtock with that of arable cultivation, the practice of incloſing muſt always be neceſſary and advantageous.

But, notwithſtanding the advantages that, in various points of view, thus evidently reſult from the incloſing of land, the practice is far from having been ſo much encouraged or attended to, as its utility and importance would ſeem to demand.

* Donaldſon's Modern Agriculture, vol. III. p. 305.

This may have proceeded partly from the difficulty that muſt neceſſarily attend the buſineſs in every caſe, and, eſpecially in waſte or common-field lands, from the diverſity of claims, and partly from the improper conduct or miſmanagement of thoſe who have the direction of it.

It may, therefore, not be improper to take notice of ſome of the leading circumſtances that ought to be regarded in directing the means of ſuch incloſures.

In the incloſing of waſtes and commons, much oppoſition and delay often proceeds from the cauſes juſt mentioned, as well as from a neglect of, or inattention to, proper accommodation in the ſmall allotments, ſuch as thoſe of cottagers, and other labourers who have claims.

In the management of incloſures it is, therefore, neceſſary that due attention ſhould be had to the rights and intereſts of cottagers, and the labouring claſſes, who have ſmall claims, as well as thoſe of the larger proprietors. Mr. Bellingſley, in his able report of the Agriculture of the County of Somerſet, has, indeed, obſerved, that whether the incloſing of commons be accompliſhed " by the unanimous conſent of the parties claiming rights, who delegate power to commiſſioners, choſen by themſelves, to aſcertain their validity, and divide accordingly under covenants and agreements, properly drawn and executed for the purpoſe, or by act of parliament obtained by the petition of a certain proportion of the commoners; it is manifeſt that the rights of the cottager cannot be invaded, ſince, with reſpect to legal or equitable conſtruction, he ſtands preciſely on the ſame ground with his more opulent neighbours." And in regard to his intereſt, he remarks, that, in all the caſes that have fallen under his obſervation, " incloſures have ameliorated his condition by exciting a ſpirit of activity and induſtry, whereby habits of ſloth have been by degrees overcome, and ſupineneſs and inactivity have been exchanged for vigour and exertion." The reduction of the poor-rates in many of thoſe pariſhes where incloſing has been practiſed, is, he thinks, a ſtrong proof of the truth of the poſition.

In conducting the buſineſs of an incloſure, it would ſeem to be the moſt proper method for the commiſſioners, after aſcertaining the nature and quantity of land, and marking out the neceſſary roads, bridges, &c. in the moſt eaſy and convenient directions, to apportion out the allotments of the ſmalleſt proprietors firſt, without the leaſt diſtinction of perſons, ſo as to render ſuch allotments as ſuitable and convenient as poſſible for thoſe who are to occupy them; as it is ſufficiently obvious that the ſmall claimant might as well have no allotment at all, as to have it at ſuch a diſtance from his dwelling as to be managed with great

inconvenience and diſadvantage, or in a way that muſt prevent him from going to, and performing his daily labour; under ſuch circumſtances he would moſt probably have no alternative but that of diſpoſing of his little property, which might otherwiſe be of great utility to him, to his more opulent neighbour. From ſuch ſmall claimants they ſhould progreſſively advance to the largeſt proprietors, having conſtantly an eye to the accommodation and convenience of each, but without permitting any injury to be done thereby to another. This is unqueſtionably a very difficult, as well as troubleſome part of the buſineſs; but by proper attention, a complete knowledge of the ſubject, and proper management, much may be ſatisfactorily accompliſhed.

In caſe of the town being ſituated near to, or in the middle of, the incloſure, the allotments of the different proprietors may often very properly be laid out in ſuch a way as to join, or nearly join, to the farm houſes; and they ſhould likewiſe be as much in ſquares as their nature will admit of; but where the caſe is the contrary, the allotments at a diſtance ought to be ſo diſtributed, as to render them moſt advantageous for occupation as farms, on which houſes and proper offices may be built, regard being always had to the convenience of water, and to different ſorts of land, as well as many other points of conſtant importance to the farmer.

It would probably, too, be a meaſure of ſound policy, as well in a national as other points of view, to have a proviſion in bills of incloſure, for the building of a certain number of cottages, proportionate to the extent of the incloſed common or waſte, with a ſmall allotment of land annexed to each, at leaſt as much as is ſufficient for a garden, which, in general, need not exceed a rood. Theſe cottages ſhould be ſolely deſtined for the uſe and advantage of ſuch poor labouring perſons as belong to the pariſh. Such a regulation as this would probably be attended with many good conſequences; it would render the buſineſs of incloſing leſs objectionable to the labouring cottager, promote the cultivation of land, and at the ſame time have a tendency to leſſen the expences of the poor. For it is a curious and important fact, that in moſt pariſhes where no incloſures of waſte lands have been made, the rates for the ſupport of the poor have been increaſed to an aſtoniſhing degree*. In ſome inſtances, even in a treble and quadruple proportion.

It is well obſerved by a noble writer, who we have had occaſion to quote before†, that "upon an incloſure, if the owners chooſe it, the labourers who

* Billingſley's View of the Agriculture of the County of Somerſet.

† Earl of Winchelſea in Communications to the Board of Agriculture, vol. I.

keep cows may be placed in a much better ſituation than they were, inaſmuch as incloſed land is more valuable to occupiers of every deſcription, than commons and open fields. Garden ground may alſo be allotted to them, as well as others, which cannot be done while the land remains unincloſed." He is perſuaded that " where theſe things are attended to, very few objections to an incloſure will ariſe on the part of the labourers, and that the land owners will have the ſatisfaction of benefiting the poor, and at the ſame time of making their own property more valuable, by adopting what, in all probability, will be the means of keeping down the poor-rates."

Wherever the ſyſtem of incloſing is adopted, much care and circumſpection is neceſſary, in order to guard againſt expence, in the appointment of perſons for the conducting and managing of the buſineſs. None but ſuch as are known to be fully capable ſhould be fixed upon, either as ſolicitors for promoting and procuring the act of parliament, when neceſſary, or commiſſioners for tranſacting and arranging the buſineſs of the incloſure. After ſuch act has been obtained, it is a matter of great conſequence in appointing the latter, to have them from the vicinity of the incloſure, that they may be acquainted not only with the different local circumſtances and peculiarities of the place, but the nature of the ſoils, and the beſt means of their being improved. Some of them too ſhould always be perſons who have a perfect knowledge of the forms and modes of conducting the buſineſs, and a practical acquaintance with accounts, and the prices of making all ſorts of fences, gates, roads, bridges, drains, &c. as well as ſufficient information both of the theory and practice of agriculture itſelf; much of theſe various ſorts of knowledge being conſtantly required in the conducting of an incloſure.

Where perſons are thus qualified, and without it errors and miſtakes muſt be continually committed, two, or at moſt three commiſſioners, will generally be fully adequate to the execution of the buſineſs, even in the moſt extenſive incloſures. And in many caſes where the waſte land to be incloſed is ſmall in quantity, one intelligent commiſſioner may be ſufficient for the purpoſe.

Where country ſolicitors are employed, they may act as clerks to the commiſſioners, by which a conſiderable ſaving of expence may often be made; or this may, in moſt caſes, be accompliſhed by the commiſſioners entering their own minutes and orders, which, in general, is attended with but little trouble. The office of ſurveyor, as being, in general, expenſive, ſhould be cautiouſly diſpoſed of. The beſt mode is probably that of fixing an adequate ſum for the tranſaction of the whole of the buſineſs that may be requiſite, after the act has been procured; care being taken that the perſon who engages be duly qualified, and of eſtabliſhed cha-

racter, for the office. Such a plan would not only ſave much trouble, but, in different inſtances, conſiderable expence to the proprietors.

Another circumſtance which ought to be particularly regarded in the incloſing of commons, is that of no greater delay being permitted in giving the different proprietors poſſeſſion of their allotments, than is abſolutely requiſite. If theſe ſeveral points were ſufficiently attended to, there would probably be very little reaſonable objection made to the ſyſtem of incloſing; as thoſe which have been advanced, on the grounds of injuries done to the breeding of cattle, the expences of farming buildings, the deterioration of the quality of wool, or the diminution of its produce, by a reduction in the number of ſheep, and the leſſening of the rental value of ſuch eſtates as are in the neighbourhood of incloſed commons, are, when fully examined, too feeble and unſatisfactory to deſerve much regard*.

It is forcibly obſerved by the able writer of one of the county reports on agriculture, that, "when the incloſing ſyſtem is appreciated, by its obvious tendency to increaſe the produce of land, and the demand for labour, to augment the rate of wages to the huſbandman, and to leſſen the amount of the poor-rate; it is a ſubject of regret and aſtoniſhment, that ſo few means have been deviſed by the legiſlature, either to facilitate or extend its progreſs. How much is to be done this way," ſays he, "a general incloſure act, unfettered by tedious and expenſive formalities, would ſpeedily manifeſt. From the very great number of private acts which have paſſed within the laſt twenty years, ſuch general principles might," he ſuppoſes, "be ſelected for its baſis, as to implicate almoſt every poſſible variety of claim, intereſt, and property. An act thus conſtituted," he thinks, "might, without hazard or injury, be entruſted to a given number of juſtices at the quarter ſeſſions, to diſpenſe its powers, and control its execution; and ſuch juſtices," he conceives, "perfectly competent to determine on the propriety or impropriety of any propoſed incloſure. Thus," continues he, "a total extinction of parliamentary expence would encourage incloſing on the ſmalleſt ſcale; and, with advantages not to be deſpiſed, would accommodate the moſt extenſive†."

That ſuch a meaſure is calculated to promote the advantage of individuals, as well as that of the nation, cannot be much doubted by thoſe who have at all conſidered the nature of the ſubject. We therefore hope that a general act of incloſure may, at no very diſtant period, be obtained, notwithſtanding the inju-

* See the obſervations of Mr. Bellingſley on theſe points in his Report, p. 53.

† Billingſley's View of the Agriculture of the County of Somerſet.

dicious, illiberal, and very inconſiderate oppoſition it has hitherto experienced, by which thoſe numerous commons and waſte lands, that have ſo long remained in a barren and unproductive ſtate, to the diſgrace of the country, and the reproach of agriculture, may be put under a ſyſtem of cultivation and improvement.

The benefits which would be derived from the general incloſure of commons would no doubt be various. In addition to the increaſe in the value of ſuch lands to the owners, which, as has been obſerved, would be conſiderable in many places, eſpecially near large towns*; in regard to the public, it would be of ſtill more extenſive utility. It would, likewiſe, be the means of raiſing and ſupporting a more numerous, as well as a much better breed of neat cattle and ſheep, and of preventing the latter from being attacked and de-

* The increaſe in the value of waſte land, which may be effected by this means, and that of proper drainage, is fully ſhewn in the following uſeful Table, drawn up by Mr. Parkinſon of Aſgerby, ſteward to Sir Joſeph Banks, and inſerted by Mr. Young in his View of the Agriculture of the County of Lincoln.

Statement of Improvements.

Pariſhes.		Improved value.	Old value.	Improvement.	Expenditure.	
	A. r. p.	*£. s. d.*	*£. s. d.*	*£. s. d.*	*£. s. d.*	
Donnington -	1728 0 0	681 5 0	380 0 0	301 5 0	1100 0 0	
Swaby - -	1555 1 24	738 5 6	310 14 0	427 11 6	1967 13 0	
Belleau - -	649 1 14	323 8 0	274 0 0	49 8 0		
N. Rauceby -	3168 0 23	1129 16 0	352 0 0	777 16 0	3399 0 0	
S. Ditto - -	2461 0 20	1010 18 7	347 0 0	663 18 7		
Normanby -	1718 3 20	1021 18 3	480 0 0	541 18 3	1820 0 0	
Huttoft -	3352 0 16	2356 2 0	1800 0 0	556 2 0	2300 0 0	
Hemſwell -	2581 2 20	1472 2 6	630 3 0	841 19 6	1874 0 0	
Legburn -	2335 2 3	973 14 7	655 0 0	318 14 7	1663 0 0	
Canwick -	2059 3 33	1437 5 0	672 12 0	764 13 0	1722 0 0	
Skindleby -	1028 1 25	571 3 1	285 0 0	286 3 1	800 0 0	
W. Enderby -	798 0 0	526 4 8	340 0 0	186 4 8	848 10 7	
Anwick fields, &c.	954 0 0	708 19 0	385 3 0	323 16 0	1510 0 0	
Greetham -	1275 0 29	763 2 6	400 0 0	363 2 6	1348 0 0	
Hagg - -	2383 2 13	1806 17 0	1560 0 0	246 17 0	2100 0 0	
Kirton - -	4583 0 0	3864 3 7	1168 0 0	2696 3 7	5267 16 9	
Nettleton -	3549 2 32	1523 17 0	460 0 0	1063 17 9	2425 0 0	
Oſbornby -	1475 2 0	1323 7 0	662 0 0	661 7 0	2032 12 1	
Scarthe - -	1186 2 0	876 15 0	452 0 0	424 15 0	1447 1 6	
Quarrington -	1500 0 0	1268 8 0	627 0 0	641 8 0	3669 0 0	
Sleaford and Holdingham	2321 1 20	2191 2 0	918 0 0	1273 2 0		
Dunſten heath and fields	1957 0 20	1037 1 3	641 0 0	396 1 3	1300 0 0	
Tatterſhall incloſure	4003 2 18	2168 1 11	1706 11 8	461 10 3	626 0 0	
Fens—Ditto embankment	892 0 26	838 13 9	387 19 9	450 14 0	3630 0 0	
Anwick Fen -	1097 0 0	703 16 0	54 17 0	648 19 0	4070 0 0	
The nine embanked fens from Tatterſhall to Lincoln	19,418 1 34	15,534 8 8	1941 16 0	13,592 12 0	77,672 0 0	
Holland Fen 11 towns	22,000 0 0	25,300 0 0	3600 0 0	21,700 0 0	50,600 0 0	
Total -	92,033 2 30	72,150 15 11	21,490 16 5	50,659 19 6	175,191 13 11	

Intereſt at 5 per cent.	Net gain to the Owners.
8754 11 7	41,905 8 11

ſtroyed by diſorders, ſuch as the rot, &c. In conſequence of ſuch a ſyſtem, the markets would not only be better ſupplied with fat cattle and ſheep, but with different ſorts of grain and vegetables. Beſides, the neceſſity of making furrows, drains, ditches, and other paſſages for conveying away and removing the ſuperabundant ſurface water, in ſuch caſes, would have a great effect in rendering low ſwampy ſituations more healthy and comfortable for their inhabitants. Much immediate as well as permanent employment would, likewiſe, be created for the labourer in huſbandry, and the rural artificer; while beggary and robbery, if not wholly prevented, would probably be rendered much leſs frequent.

On population too there can be little doubt but that it would have a good effect, from the great increaſe of corn and vegetables of different kinds, as well as of cattle; and, as has been juſt obſerved, the augmented demand for labourers and artificers of various deſcriptions which it muſt produce. The facts which we poſſeſs on the ſubject are, however, yet probably too few to draw any certain concluſions from *.

Therefore, in whatever point of view the buſineſs of incloſing common or waſte land may be contemplated, it promiſes advantages of the moſt important kinds. The humble cottager, the rich proprietor, and the nation at large, muſt be equally benefited by the ſalutary influence of ſuch a ſyſtem, whenever it is allowed to take place.

FENCES.

In the incloſing or dividing of lands, by means of fences, regard is neceſſary to be had to a variety of circumſtances, ſuch as the ſize of the farms, and the nature of them, as well as the uſes to which they are to be converted; the climate, the elevation, ſituation, and nature of the ſoils; the particular objects that are in view, or to be expected from them; and the materials of which they are to be formed. It is ſufficiently evident that ſuch incloſures as are chiefly intended for the production of graſs, ought to be ſmaller than thoſe in which grain is moſtly to be cultivated and grown. On the lighter ſorts of ſandy or gravelly ſoils, too, the diviſions ſhould be ſmall in proportion to their dryneſs, and the particular kinds of crops which can be raiſed and cultivated moſt commonly, and to the greateſt advantage, upon them. And the in-

* Middleton's View of the Agriculture of Middleſex, p. 110.

cloſures on ſheep downs, and other lands where there is conſiderable elevation, ſhould, probably, have a reduction of their extent proportioned to their height, and the dryneſs of the grounds; the thickneſs of the hedges being, likewiſe, regulated by the ſame circumſtances. We are, however, aſſured, on the authority of an able agricultor, that in forty years' experience he has always found that the graſs would begin to burn, and the grain to ſuffer, firſt, in a dry ſummer, in *ſmall incloſures*, and particularly near the hedges. Where the diviſions are large, and the ſoil moiſt, great care muſt be taken in making proper drains to ſupply the want of ditches, which anſwer the ſame purpoſe when properly formed. The frequency of full-grown hedges, high ditch-banks, and trees, on the firſt ſort of ground, has conſiderable effect in preventing ſuch lands from becoming too dry, for the ſucceſsful growth of different crops. It is ſtated by a judicious writer*, that "equal care ſhould be taken to guard againſt the extremes of too much expoſure, and that of creating a thick damp atmoſphere, as the health, thrift, and beauty, of animals are greatly promoted by proper ſhelter, and a due circulation of air. For inſtance," continues he, "a low, flat, and naturally damp ſituation, divided into ſmall incloſures by high hedges and broad ſhaws, eſpecially if they abound with trees, is totally unfit for the production of corn crops, and ſtill more if it be expoſed to a northern aſpect, and incloſed with wood. In that caſe the ſun is too much excluded, and the damp cannot be ſufficiently drained and evaporated to prevent the redundancy of moiſture from chilling the better plants, leaving an herbage that will be of no value to a farmer. On the contrary, if it be free from adjoining woods, be drained, and the ditches kept well cleanſed, it would make good permanent paſture or meadow. If, in addition to theſe, the hedges ſhould be kept cloſely cut or clipt†, the fields large, the trees ‡ trimmed to the height of twelve or fifteen feet, and every poſſible method taken to promote the free admiſſion of the ſun's rays, with a perfect drainage and evaporation, it would be fit for many of the purpoſes of aration."

But though the ſtagnation of the air in confined ſituations, may have an injurious effect on vegetable, as well as animal life, by preventing the proper degree

* Middleton in his View of the Agriculture of Middleſex.

† Where hedges are clipt, they ſhould be left wide at the bottom, and tapered up to a ridge at the top; for where they are left broad at top, as is often the caſe, they are apt to ſmother the young ſhoots below, and the bottom ſoon grows thin.

‡ There ſhould probably be very few trees in hedge-rows.

of evaporation from taking place; it is not leſs injurious to the feeding of animals than the growth of vegetables, when it circulates too much or too rapidly over a diſtrict, eſpecially where the elevation is conſiderable, as in mountainous and hilly ſituations; for, in ſuch caſes, the warmth of the animals is too ſuddenly carried off by the too frequently renewed application of cold air, and the growth of the vegetable thereby much checked and retarded. In ſuch ſituations, therefore, particular attention ought to be paid in planting the hedges ſo as beſt to break off the winds they would be the moſt expoſed to. "It is as well," ſays the writer we have juſt quoted, "for the purpoſe of ſhelter, ſhade, and equable warmth, as of occaſional freſh ſupplies of graſs, that the Leiceſterſhire graziers have founded their opinion of fifty acres in five incloſures, being equal to ſixty in one."

It would ſeem, therefore, that whether land that is to be incloſed be intended for the purpoſes of paſturing, or the production of grain, root, and ſuch-like crops; it will be the moſt advantageous to avoid the extremes of very large or very ſmall incloſures, but that in the latter caſes they may be left more large and open than in the former. From ſeven or eight to fifteen or even twenty acres, according to the extenſiveneſs of the farm, for ſuch ſorts of land as are chiefly to be employed in the way of grazing, may, in general, be the moſt proper; and from eight or ten to thirty, in proportion to the magnitude of the farm, in common, may be the moſt ſuitable for thoſe of the arable kind. But whatever be the dimenſions adopted for the incloſures, great attention ſhould conſtantly be had to the convenience of water, the poſition of the ground, the purpoſes of drainage, and the bringing together as much as is eaſily practicable lands of a ſimilar quality, or ſuch as can be cultivated and ſown under the ſame circumſtances, though it may tend to render them unequal in regard to ſize, and irregular in form *. Where, indeed, there are no circumſtances ariſing from the nature of the ſituation, that prevents their being formed in a regular manner, the ſize of the farms and the courſe of the crops that can be moſt beneficially cultivated on them ſhould be principally regarded; as by their being thus made to ſuit the nature and extent of the farms, conveniences may be gained in the buſineſs of cultivating them, as well as in taking off their products, that no other mode of diviſion could probably afford †.

It may on the whole probably be concluded, that the more equable, in reſpect

* Anderſon's Eſſays, vol. I. p. 158.

† Robertſon's View of the Agriculture of the County of Perth.

to temperature, ſuch fields as are intended for paſtures can be made by means of judicious fencing, provided they be properly drained, and a due circulation of air preſerved, the better they will fatten the animals that are kept in them; but that in grounds where grain and root crops are to be cultivated, except in elevated, hilly, and very expoſed ſituations, the ſize of the incloſures ſhould be larger, and the fences leſs calculated for the purpoſes of ſhelter, as the free and equable admiſſion of air has great power in rendering the growth of ſuch kinds of crops healthy and vigorous, as well as in preventing them from being injured by a variety of cauſes to which, under other circumſtances, they muſt be expoſed: beſides the health of mankind, as has been already obſerved, would, in many caſes, be conſiderably benefited by the adoption of ſuch a ſyſtem of incloſure.

Fences are of different kinds, and conſtituted of different materials, according to the ſituations, and the particular circumſtances under which they are made; but, in general, ſo far as the farm is concerned, they may be conſidered either as walls and pailings, or hedges and ditches.

It muſt be obvious, from the nature of theſe different fences, that one kind of them, from its being formed of ſome ſort or other of dead material, muſt, in every inſtance, from the very period of its being completed, be conſtantly getting worſe, or proceeding to a ſtate of decay; while the other, as being compoſed of various ſorts of living plants, where properly managed and attended to, muſt be advancing to a ſtate of greater improvement and advantage. This difference fully ſhews the advantage of having recourſe to one ſort of material in preference to the other, wherever there is a poſſibility of doing it; but in ſome diſtricts, and many expoſed ſituations, it is frequently a matter of great difficulty and expence to procure ſuch ſorts of materials as would be the moſt beneficial for the purpoſe; in ſuch caſes, that ſort muſt of courſe be employed which is the moſt ready and convenient. The dead kind of fences, whether they be formed of ſtones, wood, or earth, can ſeldom, from the expence, be made by the farmer of ſuch heights or in ſuch ways as to be of much utility in affording ſhelter; they will therefore be the moſt proper for incloſing with, where that forms no part of the intention of the farmer or proprietor who is making the incloſure. Where this ſort of material is employed as a fence on elevated or hilly and expoſed ſituations, it ſhould be conſtructed in a more firm manner, and be made to ſtand higher, than when uſed in lower and more ſheltered ſituations.

WALL & EARTH FENCES.

Fig. 1.

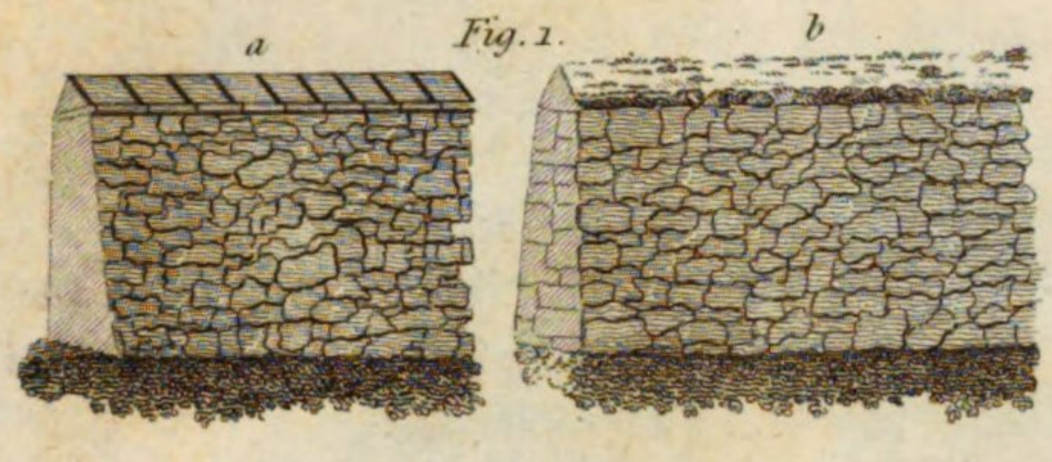


Fig. 2.

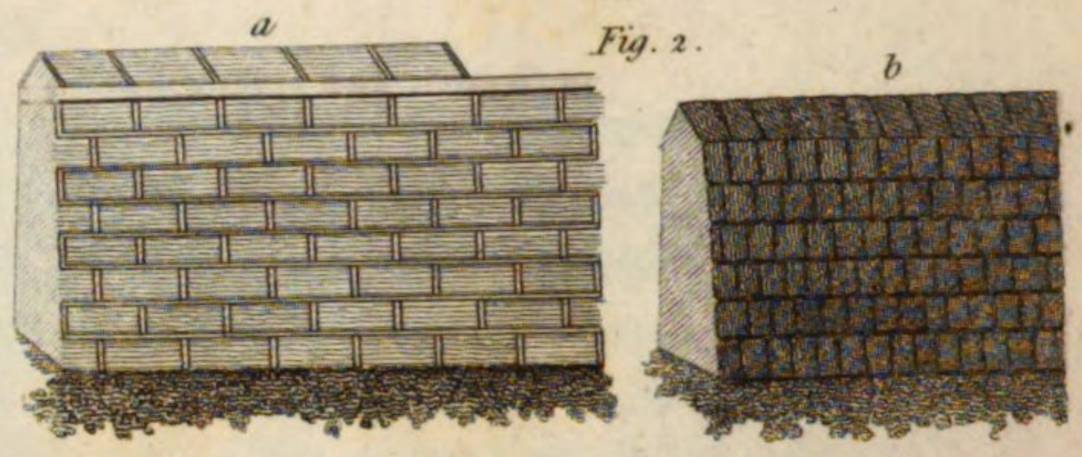


Fig. 3.

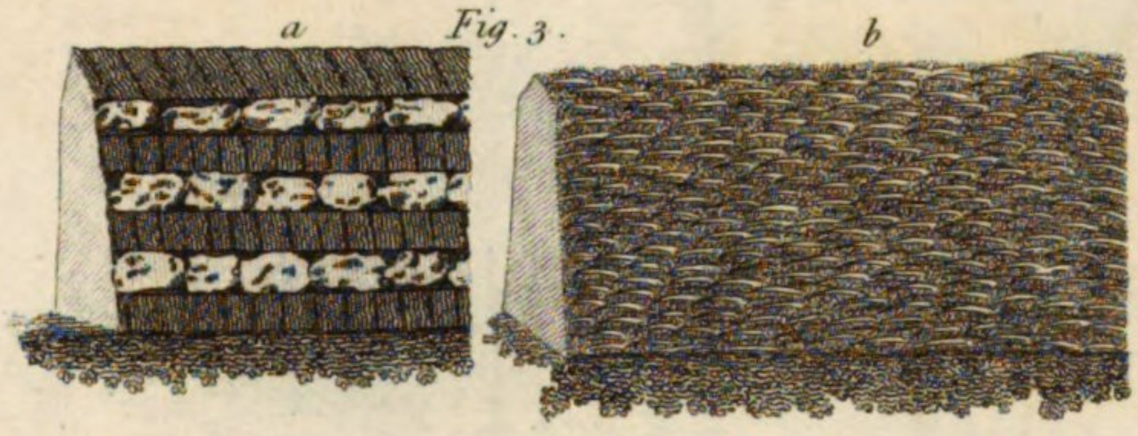


Fig. 4.

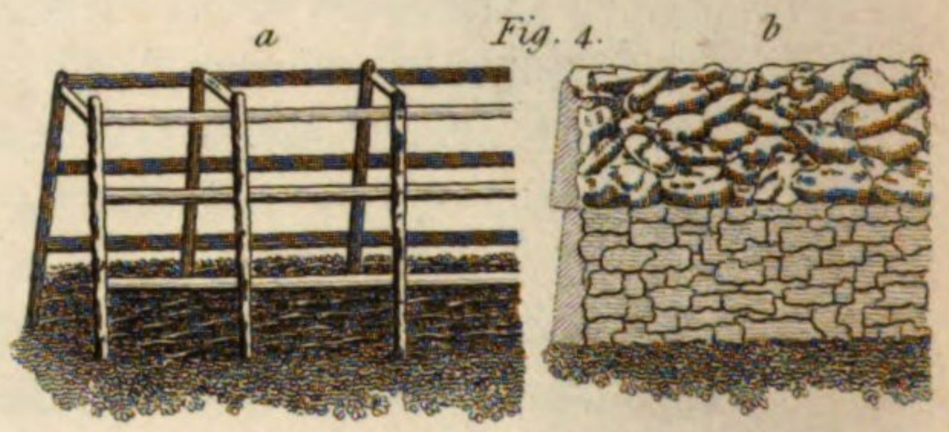


Fig. 5.

Fig. 6.

Fig. 7.

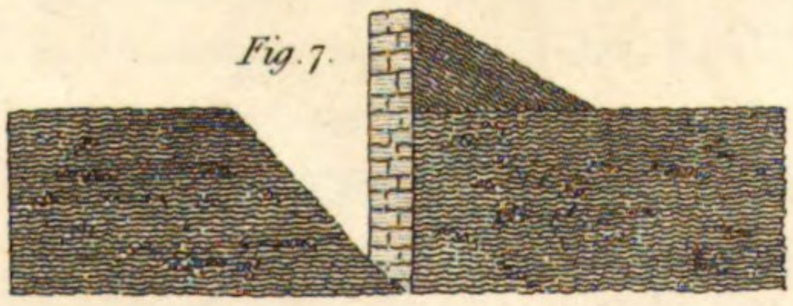


Fig. 8.

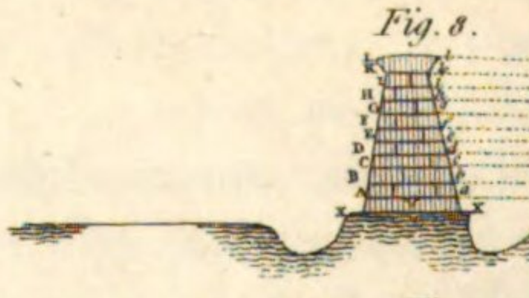


Fig. 9.

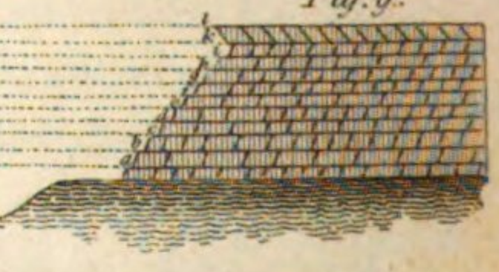


Fig. 10.

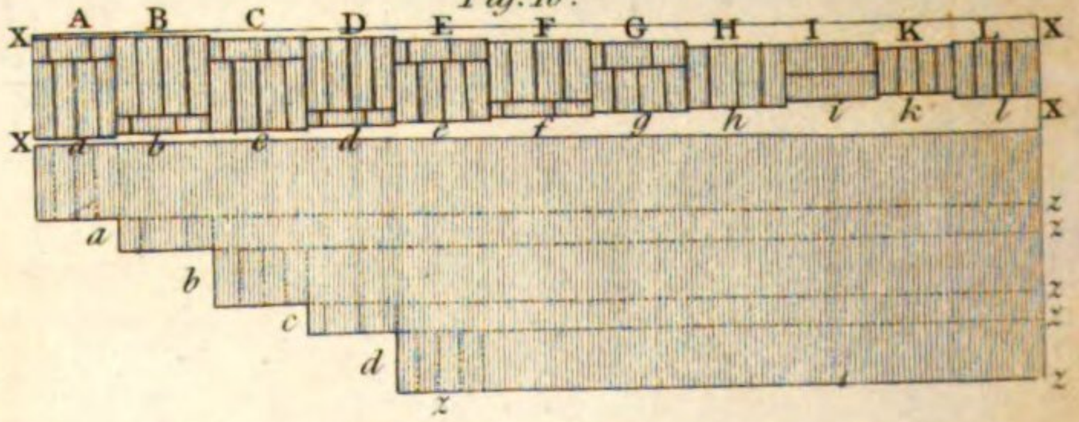


Fig. 11.

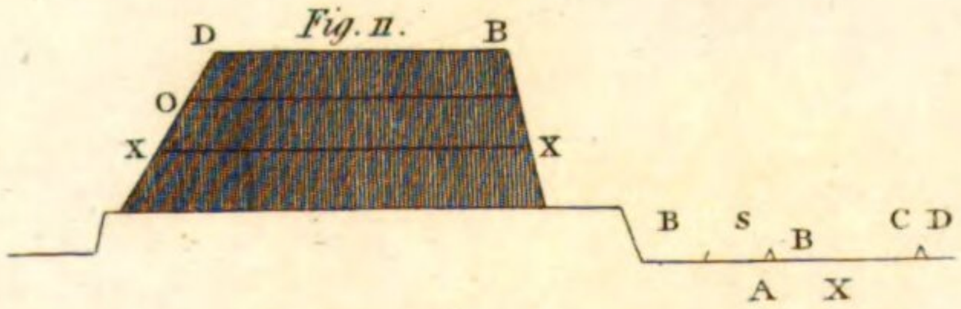


PLATE XXIX.

Wall and Earth Fences.

[*To face Page* 110.]

Fig. 1. Repreſents common ſtone walls coped with different ſorts of materials. At *a* the coping is formed with brick, and at *b* with ſod or turf.

Fig. 2. Exhibits the front of a brick wall, and alſo a wall formed wholly of turf: *a* the brick wall; *b* the turf wall.

Fig. 3. Diſplays walls conſtructed of different ſorts of ſubſtances in combination: *a* is a turf and ſtone wall; *b* a mud and ſtraw wall.

Fig. 4. Comprehends a frame for conſtructing mud walls with a dyke wall: *a* the mud wall frame, *b* a gallaway dyke or wall.

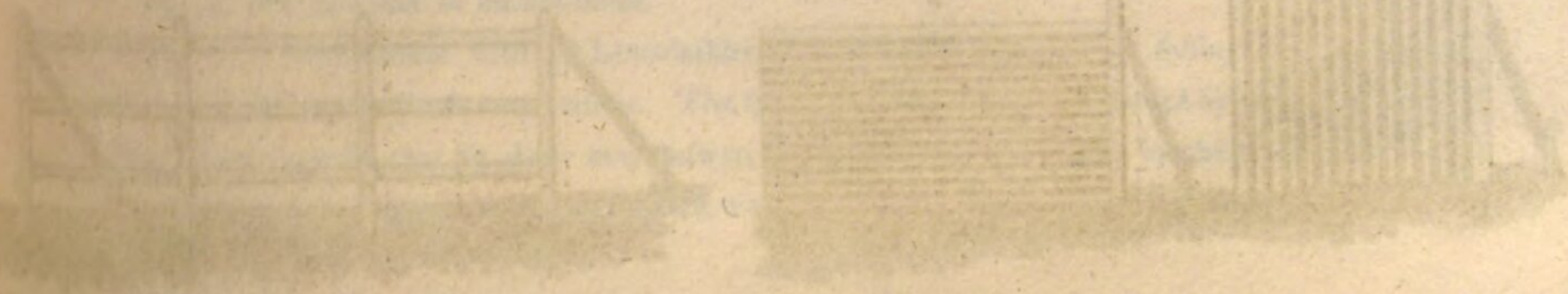
Fig. 5. Shows a ſimple dyke or ditch fence; the quicks are put in behind the earth thrown up, and protected by a dead hedge behind them.

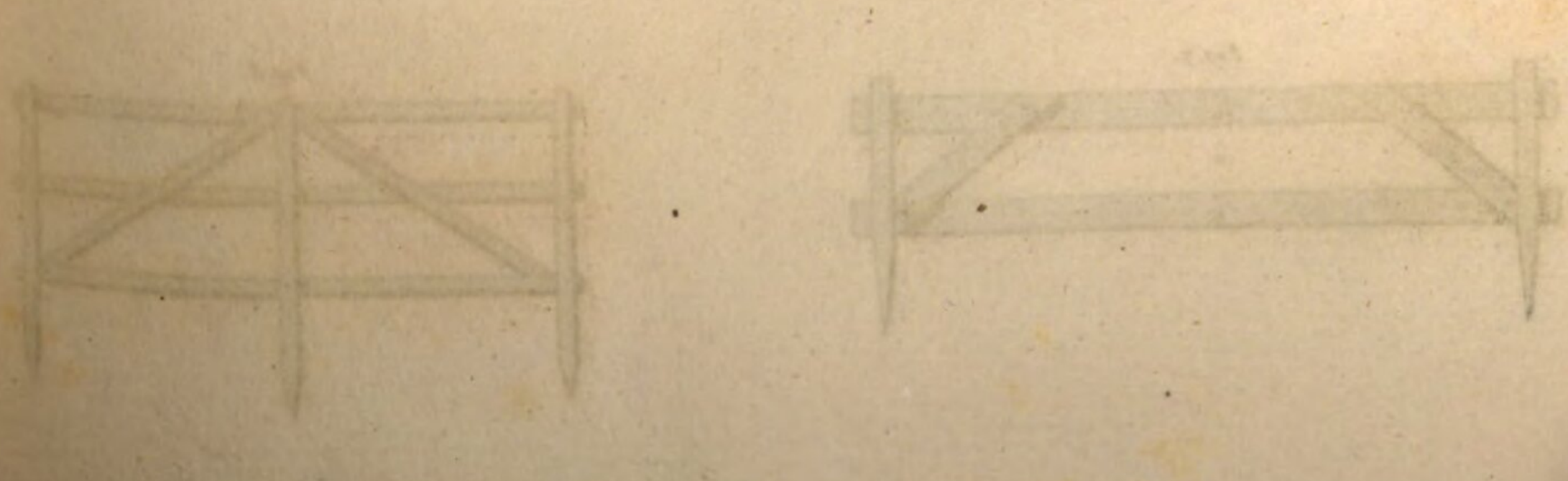
Fig. 6. Shows the double ditch, the earth taken out being formed into a bank in the middle. Quicks may be planted on one or both the ſides of the banks according to circumſtances, and protected by hedges when neceſſary.

Fig. 7. Is a ſunk fence faced with ſtone. When faced with turf this ſort of fence ſhould have a ſlanting form.

Figs. 8. 9. 10. and 11. Repreſent the manner of forming earthen fences, ſo as to prevent their crumbling down and being deſtroyed. It is recommended by Dr. Anderſon. *Fig.* 8. is a perpendicular ſection of it. *Fig.* 9. is a ſide view, and *Fig.* 10. a perpendicular view of each row of turfs as it lies in the fence. The mode of conſtruction is thus: a long rut *x x x x* fig. 10. is made with the ſpade along each ſide, with the back to where the fence is to be, ſo as to form the cut of the turf ſlanting outward, as at fig. 8. and 11.: another rut *az* fig. 10. is then made parallel to the former, at the diſtance of the length of the turf *a* from it, with the face to the fence, ſo as to ſlope inward as at R, fig. 11. in order that the firſt row of turf may be raiſed with facility: it is then cut into ſods of proper breadth, as at dotted lines *a* fig. 10. which being raiſed by the ſpade are laid into the fence with the graſſy ſide undermoſt, as at *a* figs. 8. 9. and 10.: the other ſide being finiſhed in the ſame way, the upper ſurface of the whole courſe is pared ſmooth, and clapped down with the back of the ſpade for the reception of the next courſe: another row of turf *bz* fig. 10. is then marked off to the diſtance of the breadth of that at *b* figs. 8. and 10. from the former, with the face towards the fence; and the through band turf B on the oppoſite ſide being firſt lightly laid, this is put acroſs the ends of them lengthways, ſo as to form a ſide band *b*, figs. 9. and 10.: another rut *cz* is then formed at the diſtance of the length of the turf *e* from the former; but before it is raiſed it is neceſſary to draw a rut in the line *bz*, with the back towards the fence, which gives it the form BAC, fig. 11. leaving a ſmall triangular piece at S; ſo that when put up in the fence it has the poſition ſhown at BAC, and thus permits the oppoſite ſide band O to join intimately with it, which would otherwiſe have projected outward above as to D, ſo that the turf O could not have joined it cloſely, but have left a triangular opening in the middle, and thus rendered the

fence leſs compact and ſolid. The work is to proceed in this manner, always rutting the through band rows of turf in both ends, but the ſide bands only on one ſide, beginning every courſe with thoſe that croſs the fence. The top courſe ſhould be cut a little longer than thoſe below it, and placed with the graſſy ſide uppermoſt, ſo as to project a little, as at *L l* fig. 8. or, what is perhaps better, ſet on the edge, as in fig. 11.; as by this means the water is not only better thrown off, but the fence rendered more ſecure from cattle and the effects of wind. At the foot of the fence a ditch, as XX fig. 8. ſhould be dug on each ſide, a foot and a half or two feet deep, a ledgelet being left a few inches in breadth, to guard againſt the effects of crumbling, keep the foundation dry, and prevent the intruſion of cattle.





PAILING FENCES.

Fig. 1.

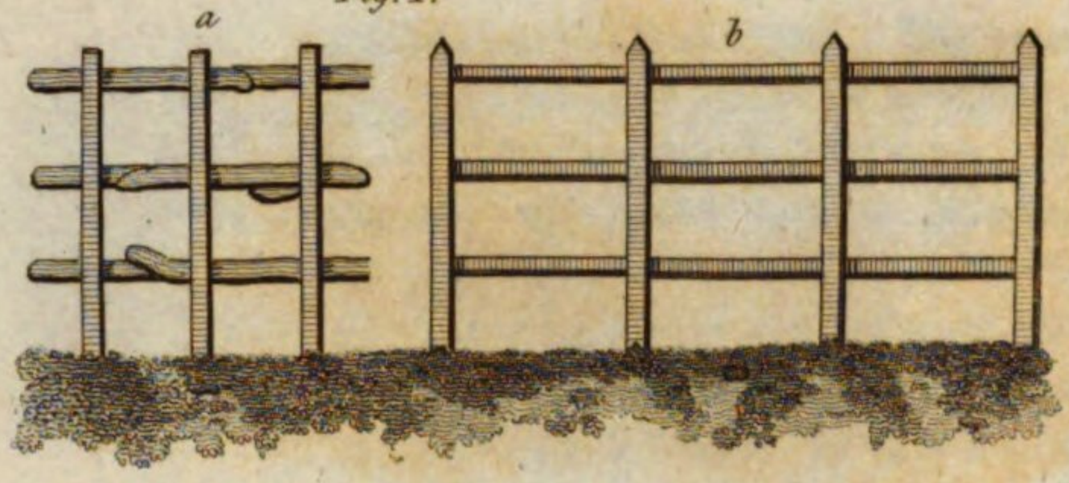


Fig. 2.

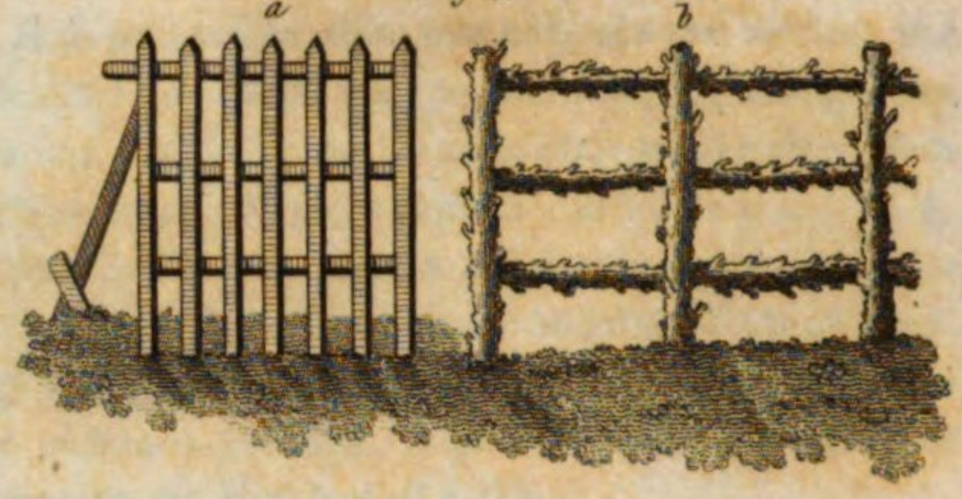


Fig. 3.

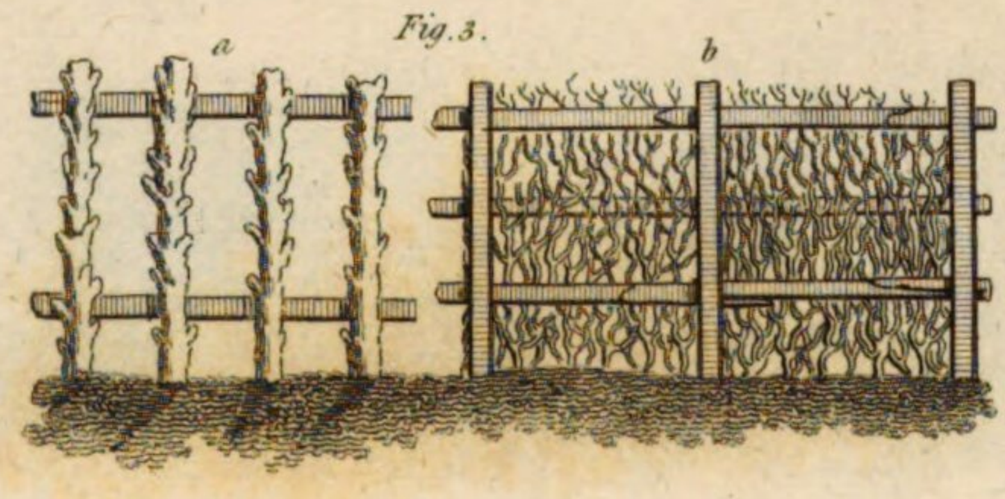


Fig. 4.

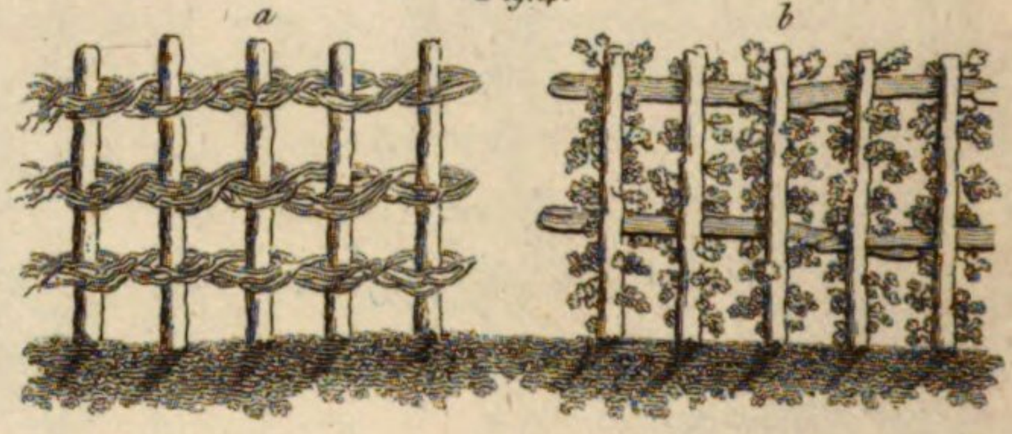


Fig. 5.

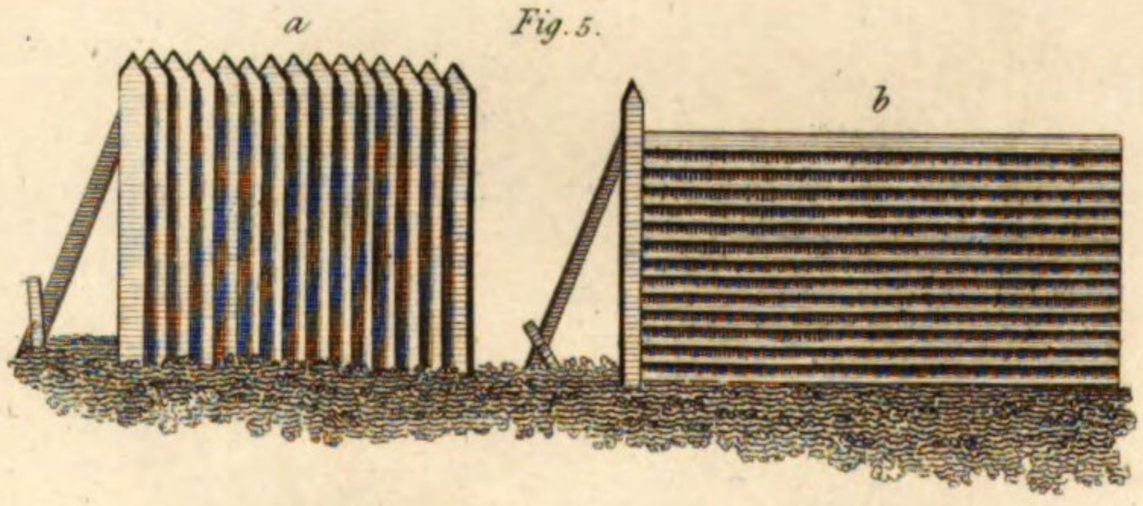


Fig. 6.

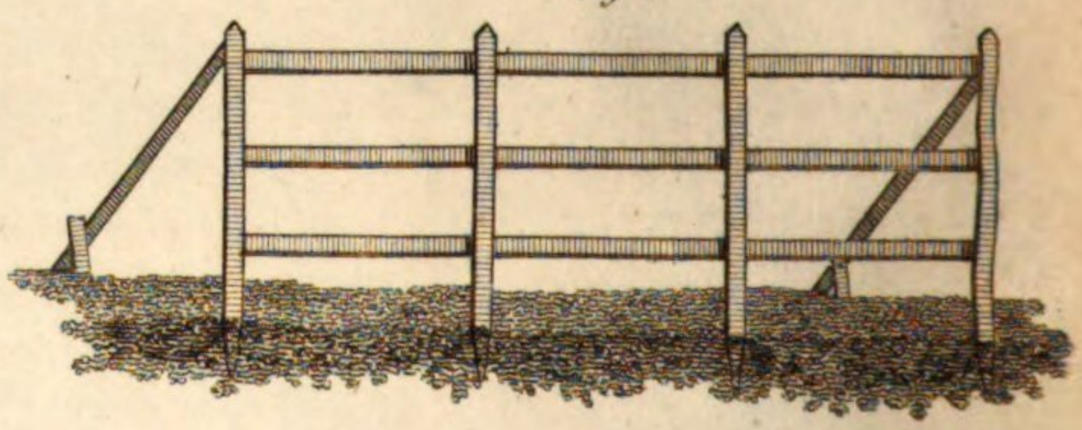


Fig. 7.

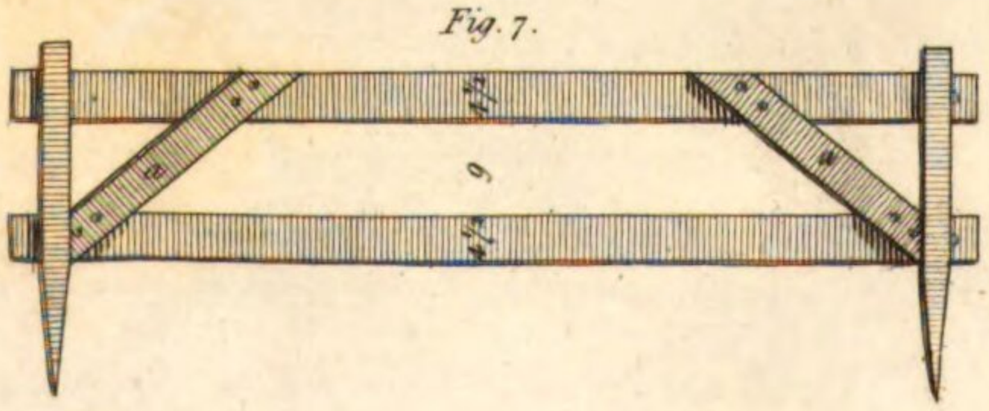
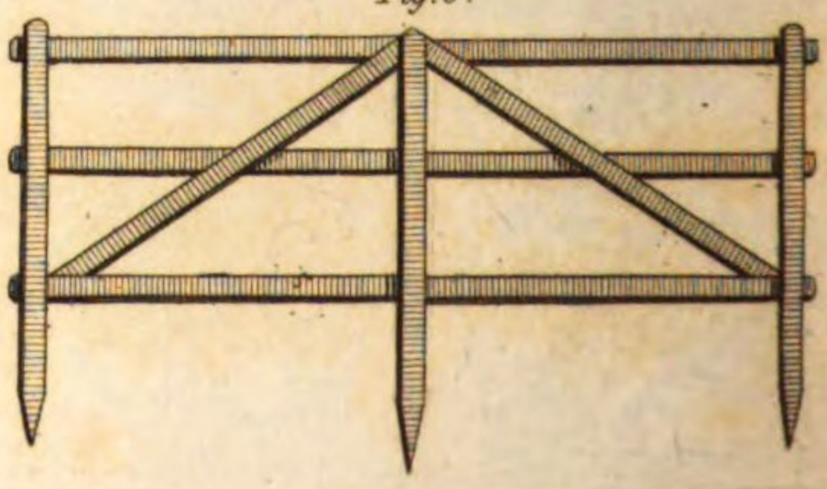


Fig. 8.



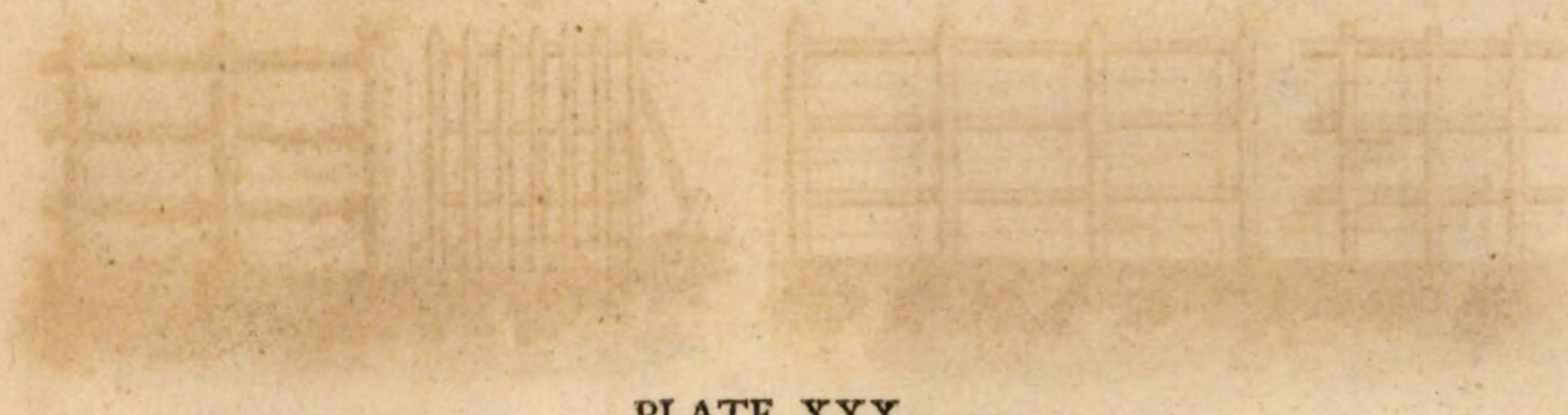


PLATE XXX.

Paling Fences.

[*To face Page* 110.]

Fig. 1. Repreſents two different ſorts of paling fences: *a*, a coarſe nailed, undreſſed, ſawn pailing; *b*, a jointed, horizontal, dreſſed paling fence.

Fig. 2. Repreſents two other ſorts of paling fences: *a*, an upright light lath paling, ſupported by reſts as neceſſary; *b*, a fir paling of the horizontal kind, made from the thinnings of trees of that kind, the lateral branches being trimmed off two inches from the ſtems.

Fig. 3. Shows two palings of another kind: *a*, an upright fir paling with the branches left as in *b*, fig. 1. *b*, an open nailed paling fence warped with thorns.

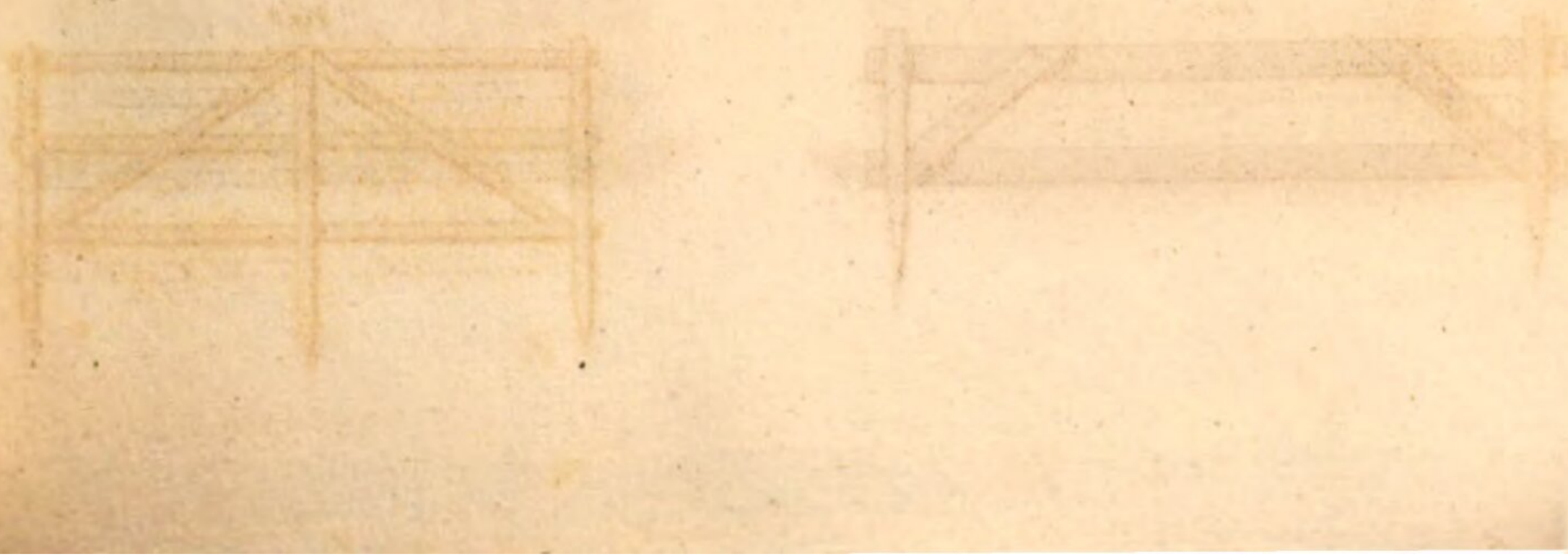
Fig. 4. Contains two other ſorts of fences: *a*, an ozier or willow fence wattled together in three different parts; *b*, a paling fence from growing trees.

Fig. 5. Exhibits two ſorts of cloſe paling: *a*, upright or park-paling; *b*, a lath horizontal paling. Theſe are very uſeful kinds of fences where cloſeneſs is required.

Fig. 6. Is a moveable or hurdle-fence.

Fig. 7. A lamb-hurdle uſed in Lincolnſhire, for preventing the lambs falling into the ditches of the paſtures in ſtormy ſeaſons. The ſpaces between the rails are cloſed by tarpaulin. Mr. Young ſuggeſts that ſlit deals may anſwer, being held in their places by the braces *aa*, one of which being moveable, the other fixed with nuts on the rivets, ſo as to admit the board to take out occaſionally.

Fig. 8. The common hurdle.



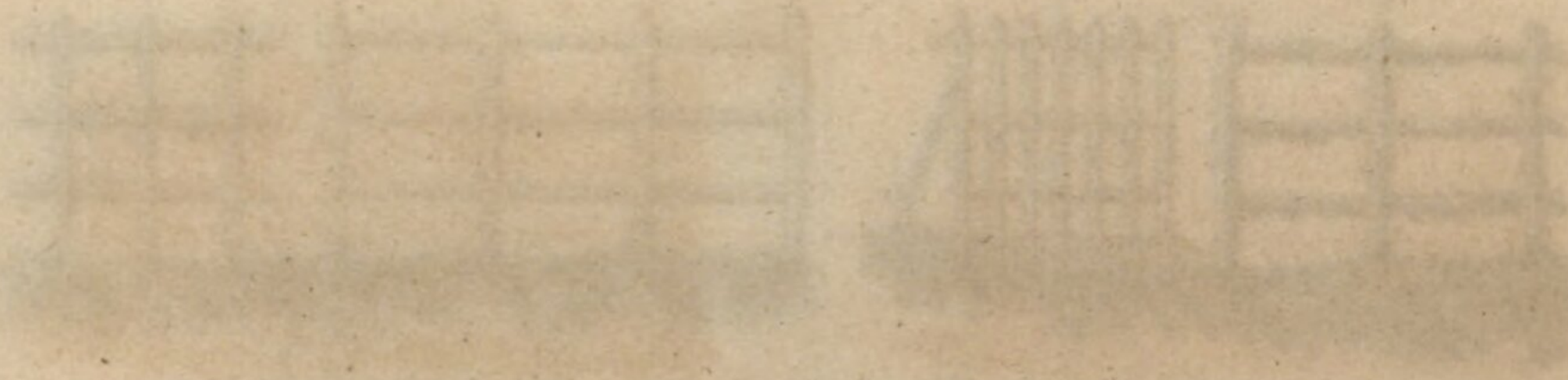


PLATE XXX.

Paling Fences.

(To face Page 110.)

Fig. 1.

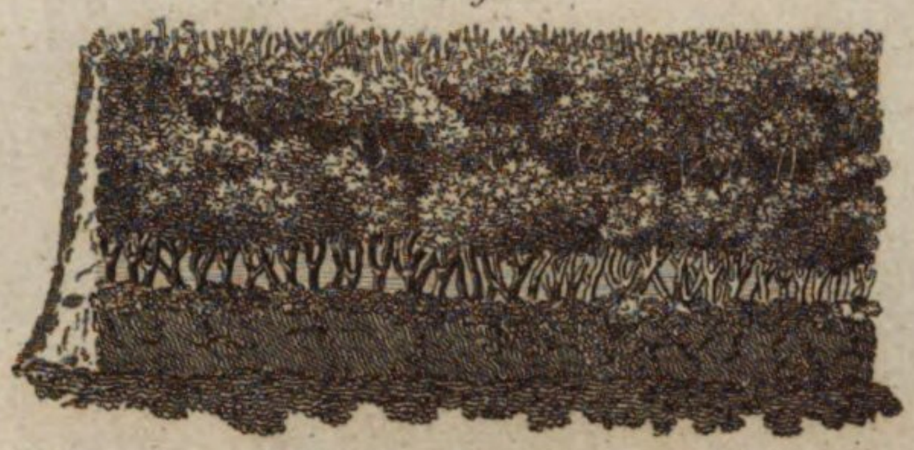


Fig. 2.

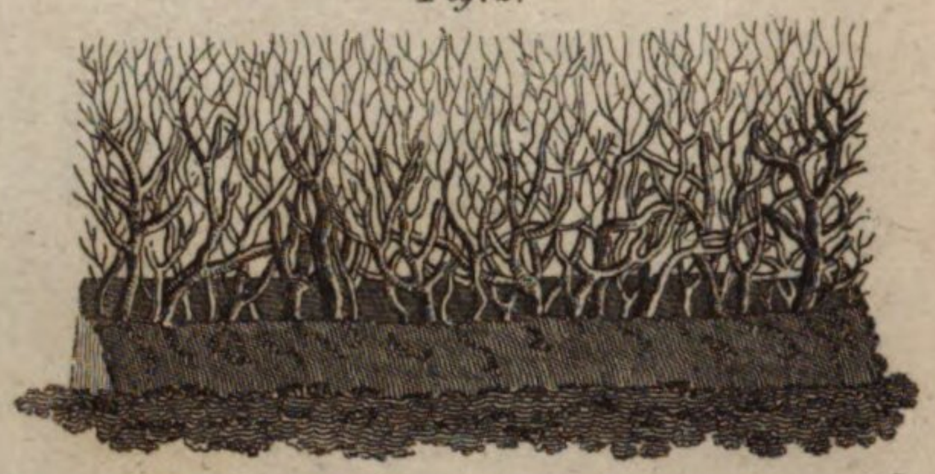


Fig. 3.

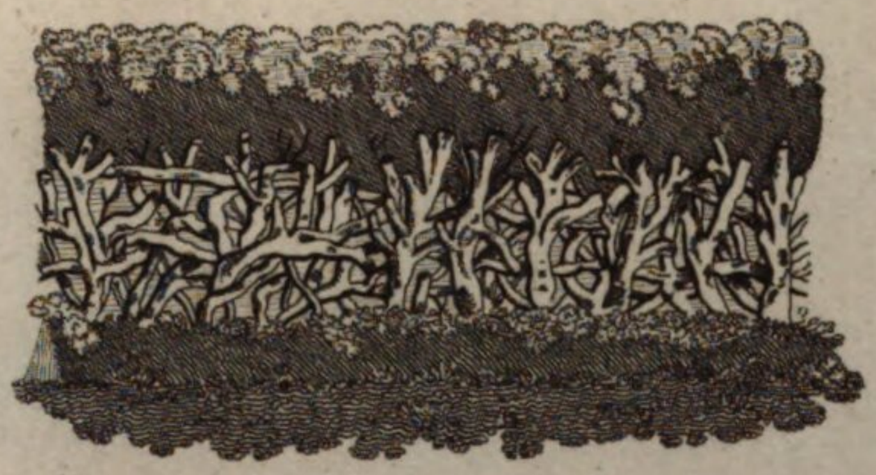


Fig. 4.

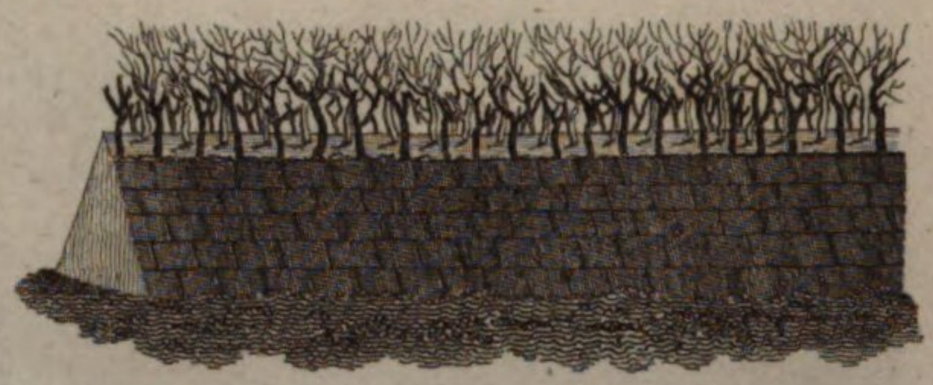


Fig. 5.

Fig. 6.

Fig. 7.

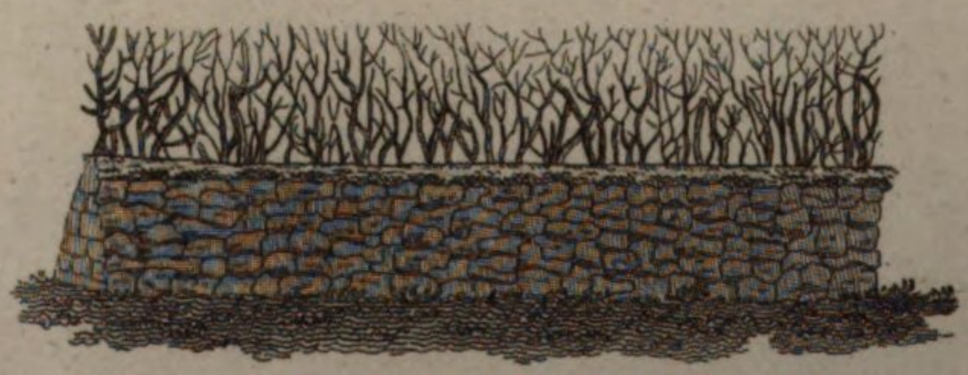


Fig. 8.

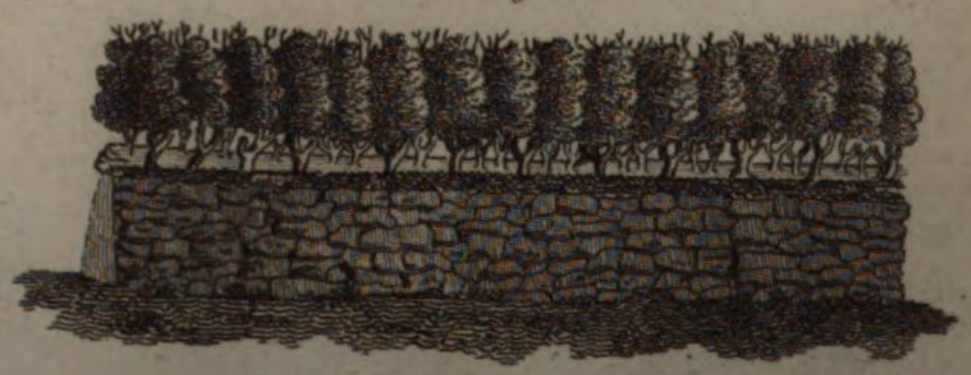


PLATE XXXI.

Hedge Fences.

[*To face Page* 110.]

Fig. 1. Repreſents a white-thorn hedge, with the leaves upon it, ſo cut and trained as to leave it in the ridge form, or broad at bottom and narrow at the top.

Fig. 2. Is the repreſentation of a hedge in the face of a bank, as deſcribed by Mr. Somerville.

Fig. 3. Exhibits a hedge at the bottom of the bank.

Fig. 4. Is a repreſentation of the Devonſhire fence.

Fig. 5. Repreſents a hedge-fence placed on the top of the bank.

Fig. 6. Shows another mode of planting a hedge upon the top of the bank, with the management of the young plants by a protection of willow-hedge, raiſed by ſetting the ſtakes.

Fig. 7. A hedge with a wall.

Fig. 8. Shows a hedge on the wall.

PLATE XXXI.

Hedge Fences.

[To face Page 110.]

Fig. 1. Represents a white-thorn hedge, with the leaves cut off and trained so as to leave it in the ridge form, or broad at bottom and narrow at the top.

Fig. 2. Is the representation of a hedge in the face of a bank, as described by Mr. Bonnerville.

Fig. 3. Exhibits a hedge at the bottom of the bank.

Fig. 4. Is a representation of the Devonshire fence.

Fig. 5. Represents a hedge-fence placed on the top of the bank.

Fig. 6. Shows another mode of planting a hedge upon the top of the bank with the young plants by a protection of willow-hedge, raised to secure the young plants.

Fig. 7. A hedge with a wall.

Fig. 8. Shows a hedge on the wall.

Hedge Fences.

Fig. 1.

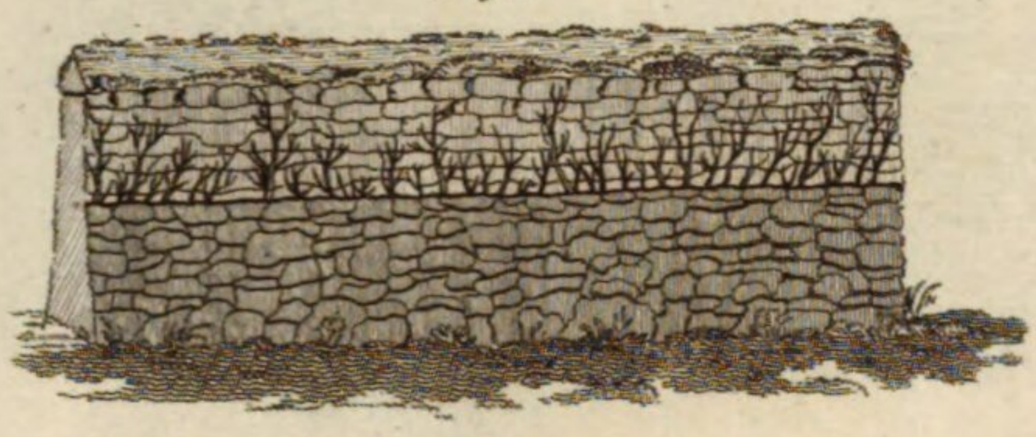


Fig. 2.

Fig. 3.

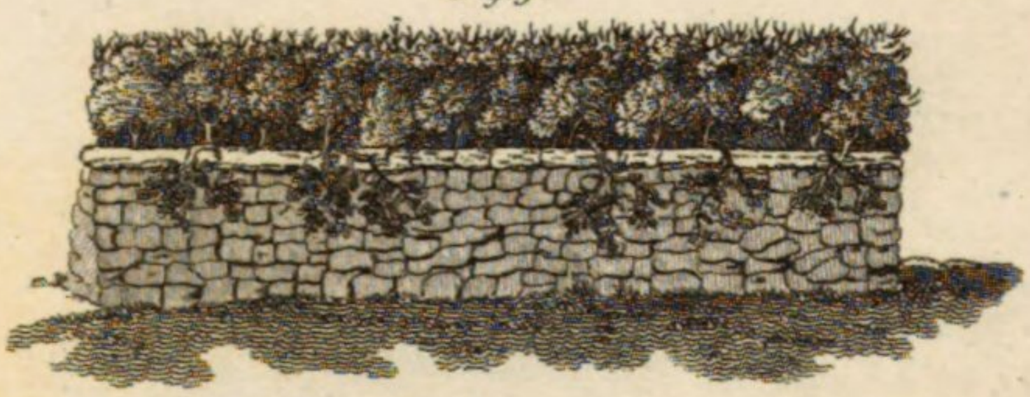


Fig. 4.

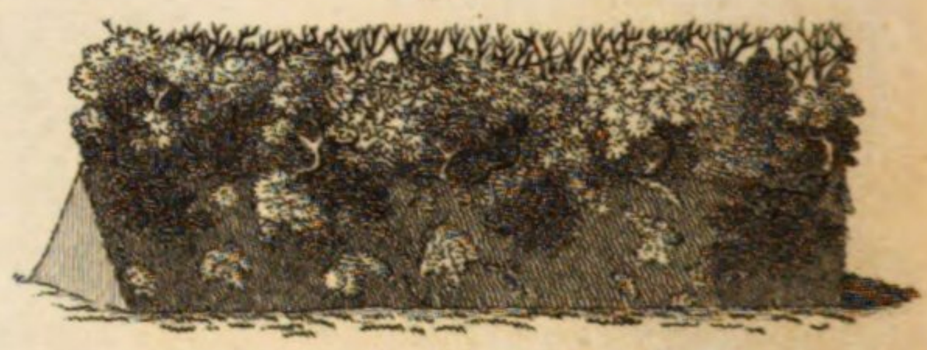


Fig. 5.

Fig. 6.

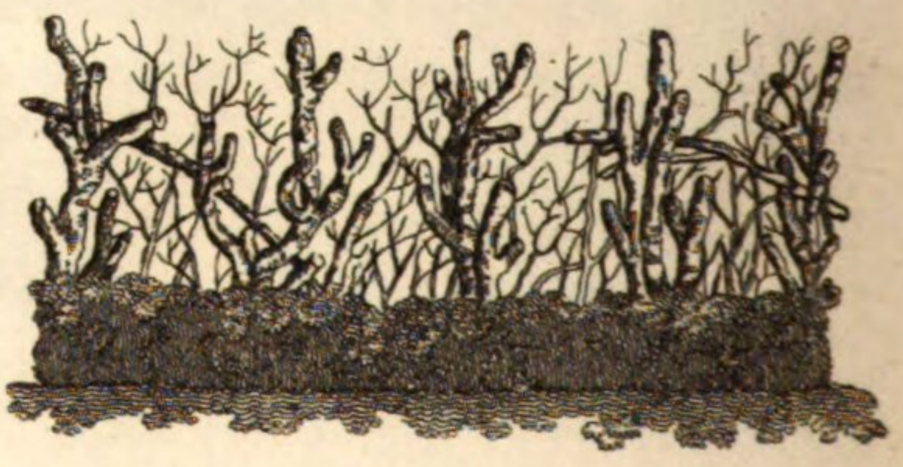


Fig. 7.

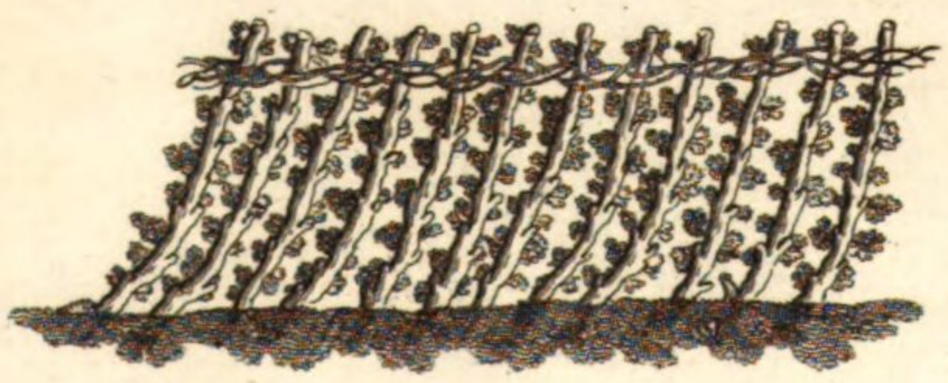


Fig. 8.

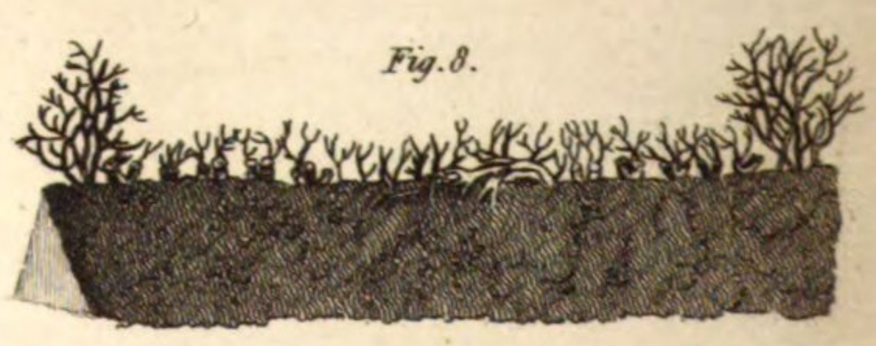


PLATE XXXII.

Hedge Fences.

[*To face Page* 110.]

Fig. 1. Is a hedge in the middle of the wall.

Fig. 2. A view of a hedge and ditch with a row of trees on the top.

Fig. 3. A furze or whin hedge on the bank faced with ſtones.

Fig. 4. A furze hedge placed merely on the top of the bank.

Fig. 5. Shows an old hedge cut over, and the young growth of the firſt year upon it.

Fig. 6. Is an old hedge cut over, ſome of the old ſtems left uncut and warped in to fill up the vacancies.

Fig. 7. Repreſents the common quick-hedge, with the ſtems nicked and bent down a little, being then bound at top with willows or hazels.

Fig. 8. Exhibits the method of mending a gap, where the old hedge is cut down, by laying one of the old ſtems, and confining it by hooks, then covering it with earth, ſo as that it may ſend up numerous ſhoots to fill up the vacancy.

PLATE XXXII.

Hedge fences.

[To face Page 110.]

Fig. 1. Is a hedge in the middle of the wall.

Fig. 2. A view of a hedge and ditch with a row of trees on the top.

Fig. 3. A furze or whin hedge on the bank faced with stones.

Fig. 4. A furze hedge placed merely on the top of the bank.

Fig. 5. Shows an old hedge cut over, and the young growth of the first year upon it.

Fig. 6. Is an old hedge cut over, some of the old trees left uncut and weaved in to fill up the vacancies.

Fig. 7. Represents the common quick-hedge, with the trees picked and cut down a little, being drawn bound at top with willow or bands.

Fig. 8. Exhibits the method of treading a gap, where the old hedge is cut down, the butts of the old trees, and spreading it by boughs, then covering it with earth, it is thus readily and expeditiously made to fill up the vacancy.

HEDGE FENCES.

Fig. 1.

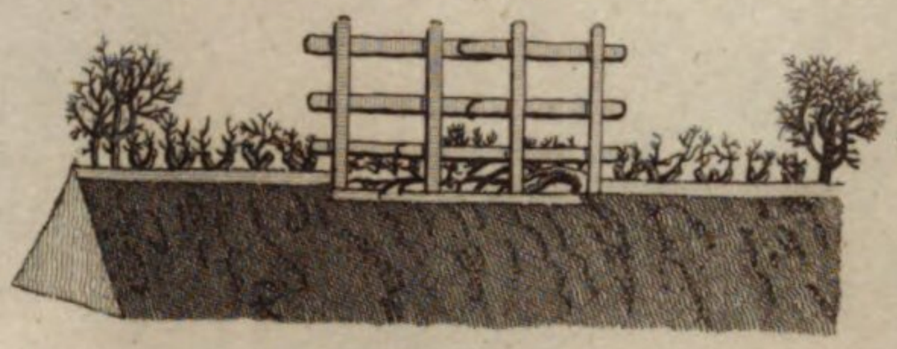


Fig. 2.

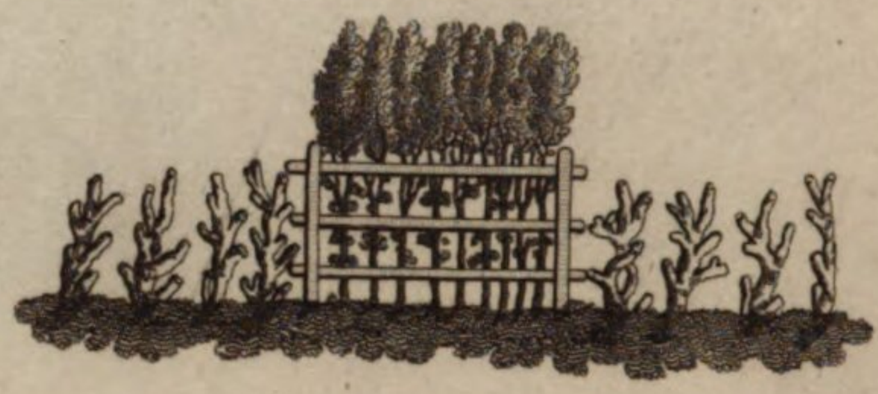


Fig. 3.

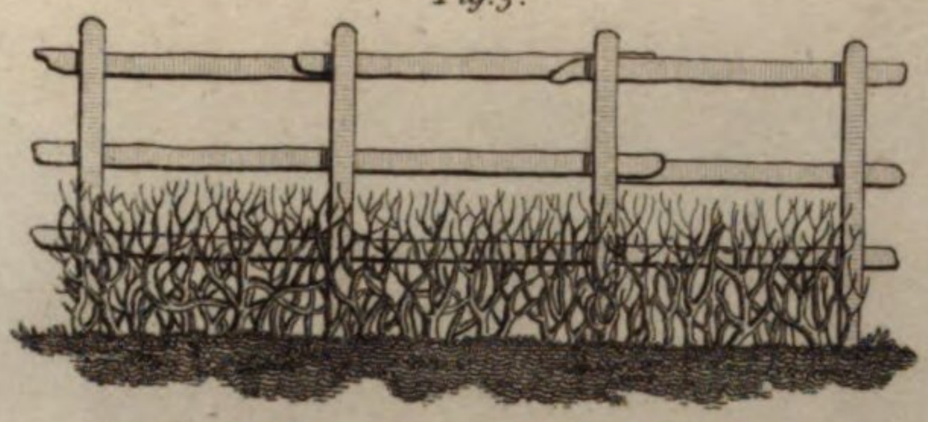


Fig. 4.

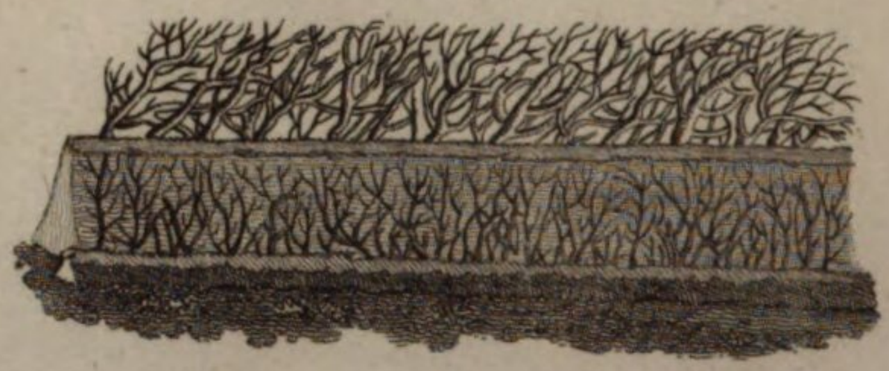


Fig. 5.

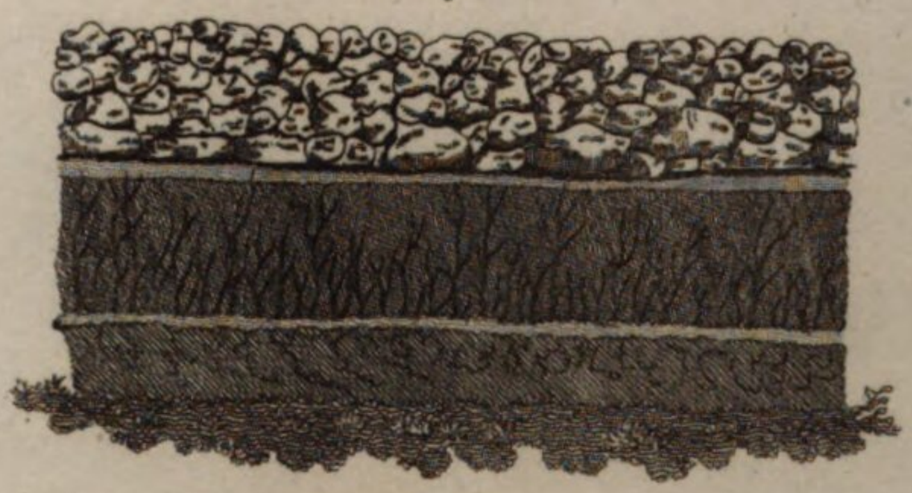


Fig. 6.

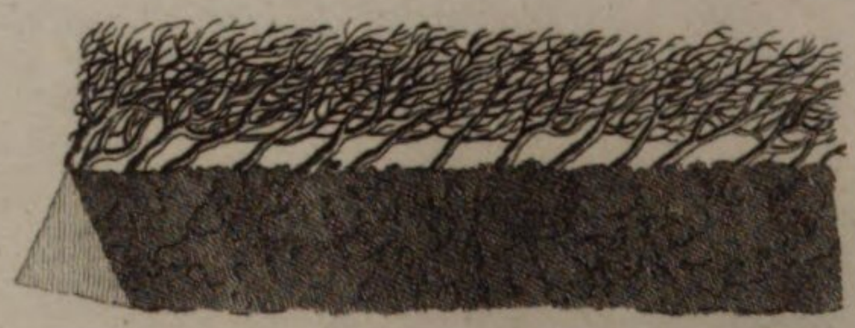


Fig. 7.

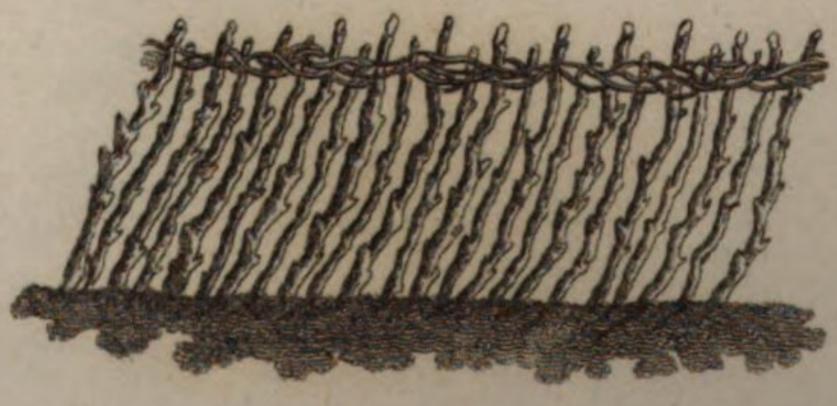


Fig. 8.

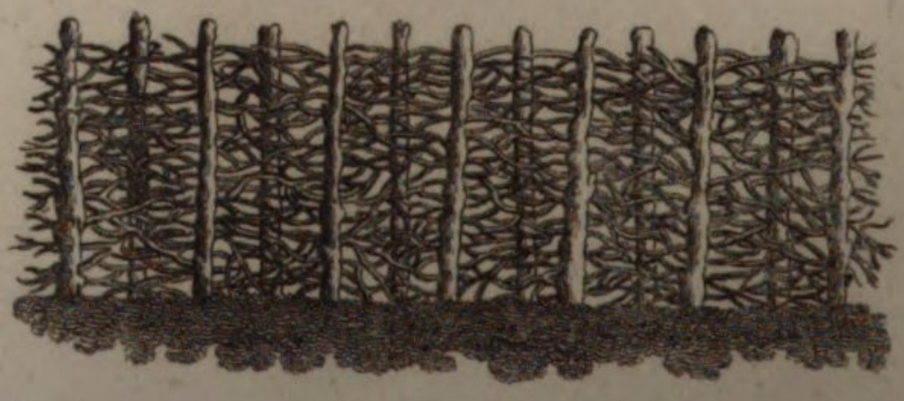


PLATE XXXIII.

Hedge Fences.

[*To face Page* 110.]

Fig. 1. Repreſents a hedge repaired in the manner as at fig. 8. Plate XXXII. and protected by a ſtrong paling in the opening.

Fig. 2. Exhibits an old thorn-hedge cut down, and an opening repaired by planting young beech trees, protecting them as in fig. 6.

Fig. 3. Is a hedge and paling.

Fig. 4. Is a hedge with a dead hedge on the top of the bank for protecting the young plants.

Fig. 5. A hedge with ditch having a coarſe wall on the bank to protect the plants.

Fig. 6. Repreſents a common dead hedge.

Fig. 7. Shows a dead hedge bound together at the top by edders.

Fig. 8. Repreſents the form of dead hedge uſually termed *ſtake* and *band*, and ſometimes *ſtake* and *riſe*. In it the dead materials are wattled in between ſtrong ſtakes.

WALLS.

WHERE ſtones are abundant, and other ſorts of materials ſcarce, the outſide, as well as the other fences, are frequently made with that ſort of material. In the conſtruction of walls, different methods are purſued in different diſtricts; they are ſometimes made ſimply of ſtones, ſometimes with ſtones and lime or mortar, but perhaps more frequently by interpoſing between the ſtones ſome earthy ſubſtance, ſuch as clay, mud, turf, or any ſimilar matter, and afterwards daſhing or pointing them with mortar or not, according to the particular circumſtances of the walls. The firſt ſort are denominated dry ſtone walls; the ſecond ſtone and lime walls; and the laſt earth and ſtone walls*. It muſt be obvious that where any ſort of earthy material is employed in the forming of theſe kinds of fences, they can neither be ſo good nor ſo durable as where ſtones alone, or ſtones with lime, are made uſe of, as from the continual action of the air, and the diſtending powers of froſts, ſuch ſubſtances quickly decay and moulder away, by which means the ſtones are left naked and looſe, and the fences ſoon become in a ſtate of ruin and of little utility. Walls of this nature ſhould therefore only be had recourſe to where there are not materials for conſtructing the more laſting kinds. Stones, when made into walls in the dry way, if the work be properly executed, conſtitute a very good and durable fence; but a better and more laſting, though in many ſituations a conſiderably more expenſive, method, is that of uſing lime, as by this means the walls are bound and cemented together, and prevented from going away and falling down.

In preparing the ground for the foundation of walls, it ſhould always be dug up to ſuch a depth as that the froſt may have no effect on it; where the ſurface of the earth is ſufficiently level, it is found a more preferable method to lay the foundation of walls on the turf than in a ſlight trench only, as in this way they are not probably ſo liable to ſink and give way. The foundation or bottom of this ſort of walls ſhould be two feet and an half wide, and the upper part from ten to fifteen or twenty inches, according to their height, which muſt vary in proportion to the nature of the ſituation and other circumſtances; but from five to ſix feet is a very common and good height. They ſhould always be coped at the top, either by means of ſtones laid edgeways, or with turf about ſix inches in thickneſs, put on in the form of an arch; the former is, however, by

* In ſome places this ſort of fence is termed *dyke*.

far the moſt adviſable method, as being the moſt durable, and affording much difficulties to animals in their attempts to get over.

In ſome places walls are made partly with a cement, and partly dry, and are termed *liſt walls;* but where a flat bed of ſtone can be had, they are generally conſtructed without the uſe of any cement whatever, and if the work be well executed, they will continue a long time. In the building of dry ſtone walls, two maſons ought conſtantly to be employed oppoſite to each other, in order that the ſurface of their work may be kept perfectly level. Long ſtones ſhould likewiſe be ſelected for the purpoſe of being placed occaſionally acroſs the wall, in order to bind it well together. Theſe are termed *throughs*, or *through ſtones*, and are commonly put about the middle of the work, in the proportion of nine or ten to every rood of ſeven yards.

The expences of building theſe different ſorts of walls in Somerſetſhire, Mr. Billingſley ſtates, to be per rope of twenty feet as follows:—

LIST WALL.

	£.	s.	d.
To quarring or digging eight loads of ſtone (25 cwt. each), at 3d.	0	2	0
To halling the ſame, ſuppoſing the diſtance half a mile, at 6d.	0	4	0
To building per rope (twenty feet), at 3s. 6d. - -	0	3	6
To ſeven buſhels of lime, at 3d. - - -	0	1	9
To covering with turf (if done very well) - -	0	0	3
	*£.	0	11 6

DRY STONE WALL.

	£.	s.	d.
To quarring as before - - - - -	0	2	0
To halling ditto - - - - - -	0	4	0
To building, at 2s. - - - - -	0	2	0
To turfing - - - - - -	0	0	3
	£.	0	8 3

* In conſequence of the advanced price of wages and of coal, fifteen or twenty per cent muſt now be added to theſe calculations.

When ſtones can be got within a wheeling diſtance, or about ſixty or ſeventy yards, it is obſerved that the coſt will be reduced about two ſhillings a rope; and that if the wall be wholly made with cement, it will be enhanced about two ſhillings and ſix pence the rope.

And in Northumberland the charge for *winning and walling* is from five ſhillings and ſix pence, to ſix ſhillings and ſix pence the rood, of ſeven yards.

The ſtones employed in the conſtructing of every ſort of wall ſhould be rendered of as flat a form as poſſible, either by quarrying, or ſome other means, before they are made uſe of; as by ſuch a practice fences of this ſort are not only conſtructed with much greater facility and expedition, but become far more ſtrong and durable.

In building of walls with ſtone and lime, the early part of the ſpring or the beginning of autumn ſeem by much the moſt ſuitable periods for the purpoſe, as they cannot at ſuch ſeaſons be much injured either by the deſtructive effects of froſt, or the too drying properties of great heat.

In the forming of walls, or what in ſome diſtricts are termed dykes, with earthy materials, or with a mixture of ſtones and ſuch ſubſtances, the methods that are followed vary according to the circumſtances of the particular caſes. In ſome, two or three feet at the bottom is conſtructed with dry round or flat ſtones, in a ſloping direction, upon which a coping of broad flat ſtones is laid, ſo as to project a little upon the ſides, upon which rough ſtones are again placed ſo as to form a kind of ridge: in other inſtances wrought clay is employed in the way of mortar between each courſe of ſtone; and in others again turf cut from the ſurface of the land is intermixed with ſtones taken from the fields, layer upon layer. This laſt is a kind of fence that may be formed in almoſt any ſituation at a trifling expence, and which may ſerve the purpoſes of temporary incloſure in many caſes. But if the ſtones be left out, and the whole wall or bank be raiſed in a ſloping direction with turfs well filled up behind, a ſtill more firm and ſolid fence may be made.

On ſtone walls Mr. Middleton very juſtly obſerves, that "ſo far as the mere purpoſe of a fence is intended or deſired they are the beſt of all, as they occaſion the leaſt waſte of ground, do no injury to the corn crops, do not harbour vermin, and are free from the weeds and rubbiſh that invariably accompany live hedges. Nor be it forgotten," continues he, "that they nearly exclude the greateſt of all vermin, to a cultivated country, *hunters**."

* View of the Agriculture of Middleſex.

It is remarked by an accurate practical obſerver, that the greateſt part of the walls or dykes of the kind that have been juſt deſcribed, which he has ſeen, were made of a conſiderable thickneſs, with a ditch on each ſide; the heart of the dyke being made up with the earth that had been taken from the ditches, and only a thin facing on each ſide was built of ſolid *feal* (turf) from top to bottom; "the conſequence," ſays he, "of which is, that as the looſe earth that is thrown into the middle of the dyke ſubſides much more than the feal on each ſide, the top of the dyke ſinks, and of courſe the two ſide-walls are preſſed too much upon the inſide, ſo as to *bilge* (or ſwell) out about the middle, and quickly crumble down to duſt." To avoid this inconvenience, he has always choſen to build dykes of this ſort much thinner than uſual, they being only three feet and a half or four feet thick at the bottom, fifteen or eighteen inches at top, and five feet high, taking care to have them built in ſuch a manner as that every ſod (feal) from top to bottom binds the joinings of the others below it, with as much accuracy as the bricks in a well-built wall. The uppermoſt courſe of feal is cut a little longer than thoſe that are immediately below it, and placed with the graſſy ſide uppermoſt, ſo as to project a little on each ſide, which is not only of uſe to throw the water a little off the wall or dyke, but is alſo of uſe in preventing ſheep or cattle from attempting to jump over it ſo readily as they otherwiſe might do. Further experience has, however, taught him, that in many caſes the coping will be more durable if it conſiſt of a row of feal ſet on edge; for when the flat-laid *feal* are withered by the ſun in ſummer, they become very light, and are apt to be blown off by the wind ſingly; whereas, when they are ſet on edge, as they lean upon each other, they are bound ſo firmly together, that no ſingle one can be carried off. He has likewiſe found, that a wall, whoſe foundation is ſtone, though perhaps the ſtones roſe no more than a foot, or a foot and a half high, having the upper part finiſhed with feal, or of alternate layers of ſtone and feal, if the dimenſions are the ſame as if it were compoſed entirely of feal, is probably more durable than any other kind of fence compoſed wholly of either of theſe materials.

At the foot of the wall or dyke, on either ſide, is dug a ſmall ditch about a foot and a half, or two feet deep, leaving a ledget of a few inches broad on each ſide, that the dyke may not be undermined by the crumbling down of the looſe earth into the ditch. "Theſe ditches," he ſays, "not only help to give the dyke an additional height, and keep its foundation dry, but are alſo of uſe to prevent cattle from coming cloſe to it, and rubbing upon it, or tearing it down with their horns, which they are very apt to do if this precaution be omitted."

In reſpect to dry ſtone dykes, or walls, he obſerves, that " if you live in a country where good free-ſtone can be eaſily got, and lime can be procured at a moderate price, a dyke built of theſe materials will be little leſs durable than a hedge; although, in general, it will neither be ſo cheap nor ſo agreeable. But that dry ſtone dykes, unleſs built of the fineſt quarried ſtone, are of ſuch a periſhable nature, as to be ſcarcely ever worth the expence of rearing; unleſs the field that you would wiſh to incloſe has plenty of ſtones upon itſelf, which muſt be carried off from its ſurface before the field can be improved. In ſuch a ſituation," he ſays, " a man may in ſome meaſure be excuſed if he ſhould be tempted to put the ſtones into dykes; becauſe the carriage of theſe materials may be ſaid to coſt him nothing, and he might perhaps be at a loſs how to diſpoſe of them in any other manner. But in all other circumſtances he apprehends it is very bad economy to rear fences of this kind, as earthen or feal dykes can always be built at about one-fourth part of the expence that theſe would coſt, will anſwer all purpoſes equally well, and if carefully built may be kept in repair for any number of years, at a very ſmall expence*."

It is likewiſe ſuggeſted that by having the joints in theſe fences bound in all directions, the whole is rendered more firm and compact than it could be made in any other way, and at the ſame time more readily formed. And that as the chief inconveniences to which they are expoſed are thoſe of their being liable to be torn or rubbed down by cattle, and to moulder away by the effects of froſt, and the action of the air, it might often be advantageous to ſet the banks with ivy, ſweet-briar, furz, or ſome ſuch kinds of plants, in order to protect them.

As earthen walls, or fences of that nature, can be formed in moſt ſituations in the way that has been deſcribed, at the expence of three halfpence or two pence a yard, they ſeem well calculated for incloſing where cheapneſs is a primary object.

Walls conſtructed in many of the modes that have been mentioned above, may frequently be made either more durable, or more ornamental, by being *daſhed*, *lipped*, or *harled* with lime.

For a limited number of years, where ſtones can be eaſily procured, there can probably be little doubt but that walled fences may be preferable to moſt other kinds, as they can be readily repaired in caſes of accident, and keep cattle very ſecure. Where the land is poor too, with much expoſure to violent and deſolating winds, ſo that live hedges cannot be eaſily raiſed, they may be found the moſt advantageous ſort of fences.

* Anderſon's Eſſays, vol. I. p. 7.

PAILINGS.

Fences conſtructed of timber can in but very few ſituations be advantageouſly employed for the purpoſe of incloſing land, except for parks and pleaſure-grounds, or they be formed of the coarſer ſorts of wood, and placed on the banks or ſides of ditches, for the protection of young thorn or other hedges, and for the dividing of fields, as occupying little room, and other uſes of the ſame nature.

The moſt cheap and common ſort of pailing made uſe of for the incloſing of farms is that in which two, three, and ſometimes four long pieces of timber, but little dreſſed or prepared, are nailed in a longitudinal direction to upright poſts of different thickneſſes, according to circumſtances, firmly ſet or drove into the ground. In ſome caſes theſe fences are rendered more firm, ſtrong, and durable, by having triangular pieces of ſown wood faſtened lengthways upon the tops of the poſts, by nails or wooden pins, with one of the edges upwards, ſo as to convey away and cover them from being injured by the effects of water. This is a much better and cheaper mode than that of making holes in the top pieces, in order to admit the heads of the poſts to paſs through them; or than that of inſerting them into the poſts, by means of mortices made in them.

Where there are coppices of young wood, either of fir, aſh, or other kinds, fences of this nature may be formed at very ſmall expence by the trimmings from them, as the work may be performed by any common ingenious labourer. Care ſhould, however, always be taken that the horizontal pieces be not fixed at too great diſtances from each other, as where this is not ſufficiently attended to, much inconvenience may be ſuſtained by animals creeping between them.

But a better ſort of farm pailing may be conſtructed by having the poſts hewen, and conſiderably thicker, and mortices formed in them to receive the longitudinal pieces. This, however, though certainly a more neat, and probably, in moſt caſes, a more laſting kind of fence, is attended with much more expence. As the cutting of mortices is liable to weaken the poſts, and by admitting water to decay them, it has been ſuggeſted to attach the croſs or horizontal pieces to them by means of ſtrong iron ſtaples*. Iron is, however, very ſubject to be deſtroyed by the action of air and moiſture, except it be kept conſtantly well covered with paint, which is not only troubleſome, but expenſive.

* Somerville in Communications to the Board of Agriculture, vol. II.

There are ſtill other kinds of pailings that may be employed as fences in particular caſes. Where ſuch pieces of timber as are proper for rails are ſcarce, a good fence may be formed by only having one nailed at the top, and another at the bottom, to the upright poſts; or, indeed, by having only one at the top, the middle being filled up by nailing ſhort thin upright pieces upon them, at the diſtance of ſix or eight inches from each other, being in the latter way left longer, and drove well into the ground. The ſlips or laths in this ſort of fence, as they are but ſhort, may be eaſily procured from ſuch kinds of wood as are the leaſt valuable, and which cannot be uſed for many other purpoſes. Such, for inſtance, as may have been procured from the lopping of timber trees, or the thinning of plantations; but in all caſes they ſhould be well ſeaſoned before they are made uſe of, as green wood not only ſoon decays, but is quickly torn by the action of the ſun.

From the cloſeneſs of this ſort of fence, it ſeems well calculated for ſuch incloſures as are to be kept in a ſtate of paſturage, and where young quick hedges of any kind are to be protected and kept from the cropping of cattle.

A cloſe kind of fence may likewiſe be made by nailing upon any of the above framings, either in a longitudinal or upright direction, pieces of fir, or any kind of timber, roughly ſown into pails of about an inch in thickneſs, and of ſuch breadths as the timber will allow, ſo as ſlightly to lap over the edges of each other. When nailed on lengthwiſe, the upright poſts muſt be placed in the ground, at ſuitable diſtances for the length of the coarſe pails or ſhingles.

There is a kind of moveable pailing-fence that may frequently be of utility in dividing incloſures or confining ſheep and other ſorts of animals, while they are feeding on different ſorts of vegetable productions, which would be much injured, and not fed off ſo economically, if they were not confined by ſome ſuch means. This is the hurdle-fence, which may be made of any ſmall ſort of wood, but ſuch kinds as are the lighteſt in proportion to their ſize ſhould be preferred. On this account the willow, the poplar, and the alder, when well dried and ſeaſoned, may be highly uſeful for the purpoſe of framed hurdles. Good hurdles may likewiſe be made by wattling young hazle plants, or others of a ſimilar kind, between upright ſtandards. Theſe are not, however, ſo neat as the former, but in general are much cheaper. Where the framed hurdle is made uſe of, it is rendered conſiderably more ready and convenient, as well as more durable, though a little more expenſive, by having the parts that are to be placed in the ground pointed with iron. Where this is done a hurdle-fence can be ſet down in a very ſhort time. In ſome caſes it might likewiſe be of great utility to have ſmall

iron loops and gudgeons at the upper parts, ſo as that the whole fence might be connected from one end to the other by them.

In the erecting of all ſorts of pailing-fences, but eſpecially ſuch as are of the more expenſive kinds, as thoſe for parks and pleaſure-grounds, great attention ſhould be paid to having the poſts of ſufficient length, in order that they may be ſet to a good depth in the ground; as without this be done, and the poſt-holes well rammed up, they are very liable to be puſhed and blown down, or become irregular in their appearance. The depths to which the poſts ought to be placed into the ground, muſt vary according to the nature of the ſoil, and the height and kind of pailing, but where it is cloſe or of much height, from two to three feet is, in general, little enough. Such a ſeaſon ſhould always be choſen for putting down the poſts, as that they may be well rammed up at the time. In wet ſeaſons this ſort of buſineſs cannot, by any means, be effectually performed; a rather dry period is to be preferred. As ſomething of the nature of putrid fermentation is apt to take place about the part where the poſts come above the ground, by which the wood is ſoon mouldered and decayed away, it is neceſſary to guard againſt it as much as poſſible, by preparing them in ſome way or other. From charcoal being known to be highly indeſtructible, poſts have been charred at the bottoms with this view, and where the operation is well and cautiouſly performed, it may be a very uſeful method. The application of tar and different ſorts of oil paints has, likewiſe, been made with the ſame intention; but as all ſuch applications are ſoon diſcompoſed when placed in contact with the moiſt earth, they can of courſe only reſiſt the decay for a very ſhort time. Of theſe ſubſtances, thoſe which penetrate the wood the moſt, are always to be preferred, which ſhould be applied when the wood is perfectly dry and free from moiſture, and the poſts be left for ſome time before they are put into the ground.

Where poſts can be had with the bark wholly upon them, eſpecially if they have been cut at a proper ſeaſon, no application of any ſort will be neceſſary, as this covering is found to reſiſt decay much longer than any artificial application of the nature of paint.

Much advantage may often be gained in preventing the decay of poſts, by the ground on which they are placed been raiſed into a ſort of ſharp ridge, ſo that the water may never be ſuffered to ſtagnate about them, the holes being made up rather higher than any other part, a circumſtance which is ſeldom much regarded.

For the covering of farm pailings, tar, as being a cheap ſubſtance, when good and well boiled, with a little ocre for the purpoſe of thickening and giving it a

body, is probably the moſt uſeful general application. It ſhould always be laid on in as hot a ſtate as poſſible, and the wood at the time be as free as poſſible from moiſture. Coal oil, if it could be rendered of a rather more thick conſiſtence, might probably be employed for theſe coarſe purpoſes with great advantage; but when uſed in the form of paint, it is liable to become flaky, and peel off.

HEDGES.

In the raiſing of quick hedges, the planter ſhould always have attention to the nature of the ſoil, and the ſituation of the ground, and of courſe adapt his plants to them; which may, in moſt inſtances, be done by attending to the growth of ſuch plants as are already on the land; and he may employ either one, or a mixture of different kinds of plants, for the purpoſe; but the latter practice is not, in general, to be recommended. On dry and tolerably good ſoils, eſpecially for outſide fences, the white and black thorns ought always to be preferred. The latter is not, however, ſo certain a grower, except the ground have a rich and rather dry friable mould; but it is more laſting, and not ſo liable to be cropped by cattle.

Some practical planters think, however, that black thorns ſhould never be put in, except upon very cold and wet land, where white-thorns will not grow; and that crab-ſets are even in theſe caſes much better; as they grow ſlow, make a ſorry weak fence, and are ſure to run and ſpread out into the incloſures.

In low ſituations, where there is much ſurface water, and where the ſoil is rather looſe and retentive of moiſture, the farmer may have recourſe to plants of the willow tribe for the forming of his hedges, as under ſuch circumſtance they grow not only with great rapidity and vigour, but are capable of being converted to a great variety of uſeful purpoſes.

They do not, however, make a very good fence, and are ſometimes apt to prove injurious to cattle, by their cropping and eating the young ſhoots too freely. Young cattle have been known to be killed by them. Where cattle are to be paſtured, it is therefore better to have recourſe to white-thorns, as they may be very well raiſed upon ſuch ſoils, by care being taken in their planting to raiſe the ground where they are placed with tw or three table turfs.

On thoſe dry and ſandy banks where there is not ſufficient depth of ſoil for the ſupport of the thorn, furze makes a tolerable fence, provided it be not ſuffered to grow too high, and be clipped or cut at proper ſeaſons.

But on ſuch banks as are liable to be carried away by the waſhings of ſtreams

of water, the alder and the willow may be planted with conſiderable advantage, as by throwing out a great number of branches from their roots, they afford great ſupport to ſuch banks.

And in very expoſed and elevated ſituations, the beech and the birch will probably be found the moſt proper plants for raiſing live hedges with, as experience has ſhewn that, by proper attention, in ſuch places they form good fences in a ſhort time.

Wherever a mixture of different ſorts of plants is employed in making a hedge, ſuch ſhould always be choſen as are capable of thriving well on the ſame kind of ſoil, and in the ſame kind of ſituation, as well as of growing with nearly equal degrees of ſtrength; for without this a very imperfect fence muſt be formed, as while ſome of the plants are getting forward with great vigour and luxuriance, others will proceed in a very feeble and ſickly manner, from being checked by the ſhade and obſtruction cauſed by the larger ones, thus rendering it thin, uneven, and defective. Beſide, ſome ſorts of plants, by being blended with others in the making of live hedges, have a diſpoſition to ſmother and deſtroy them, by too cloſely uniting with, or intwining round them. Honey-ſuckles, brambles, and many other plants of the ſame nature, have conſtantly a tendency to produce ſuch effects in hedges.

Before any kind of quick hedge is planted, the line of ground on which it is to be placed ſhould be ploughed or dug up, and undergo ſuch a degree of preparation, as will render the ſoil, of whatever kind it may be, perfectly mellow and friable, as well as leſs diſpoſed to throw up weeds; as by ſuch means the fibres of the plants will not only be more readily enabled to ſhoot out and eſtabliſh themſelves in the ground, but the plants be leſs liable to injury from the effects of weeds; from both of which cauſes young hedges often ſuffer greatly when the plants are put in, in the common mode, without the ground being ſcarcely in any way prepared for their reception. In ſome inſtances, perhaps, as where the ſoil is extremely ſtiff and tenacious, ſuch kinds of manures as have a tendency to leſſen the coheſion, may be of much utility; but in other caſes they do not ſeem to be ſo particularly neceſſary.

After the ground has been thus well broke down and rendered ſuitable for the young plants, the next thing is to put them in. This ſhould always be done in the early part of autumn, in order that the earth or mould may fall down and get well fixed about their root fibres before the winter froſts ſet in. When planted in early ſpring, which is frequently the practice, we have not found them to thrive by any means ſo well, and to be much more liable to injury from the

heats of the ſpring and ſummer, as they are ſeldom well fixed in the ſoil before theſe take place. Beſide, it frequently happens, eſpecially in the more northern ſituations, that the froſts continue ſo long as to protract their being planted out to a period when they can hardly be expected to ſucceed.

In the firſt mode, if ſufficient care has been taken not to injure the roots of the plants in trimming and taking them up, they ſucceed with great certainty, and make a very rapid growth, frequently becoming a hedge a year or two ſooner than when treated in the common method.

It has been moſt commonly recommended to take the plants for the purpoſe of making quick thorn hedges with, from the moſt poor and worſt kinds of ſoil, as by ſuch means it has been thought that they would grow more vigorouſly when removed into ſuch as are of a richer quality. It muſt, however, be conſidered, that ſuch plants as have been ſtunted in their growth, or grown in a feeble and ſickly manner, are not only a long time in recovering themſelves, but at laſt ſeldom thrive ſo vigorouſly as thoſe which have been procured from a rich ſituation. It is obſerved by an able writer, that " he has found, from reiterated experiment, that a ſtrong and vigorous plant, which has grown up quickly, and arrived at a conſiderable magnitude in a very ſhort time, never fails to grow better after tranſplanting, than another of the ſame ſize that is older and more ſtinted in its growth, whether the ſoil in which they are planted be rich or poor: ſo that, inſtead of recommending a poor hungry ſoil for a nurſery, he would, in all caſes, wiſh to ſet apart for this purpoſe the richeſt and moſt fertile ſpot that could be found; and, in the choice of plants, would always prefer the youngeſt and moſt healthy to ſuch as were older, if of an equal ſize. That he ſpeaks here from experience, and therefore does it without the ſmalleſt doubt or heſitation; being certain that future obſervations will confirm the juſtneſs of the remarks*."

As it has been found, by various practical trials in forming white-thorn hedges, that ſuch plants ſucceed the beſt as poſſeſs the greateſt number of fibrous roots about the bottom of their ſtems, it is a matter of importance to adopt ſuch methods as tend to produce ſuch effects while they are in the nurſery. This may, probably, be much effected by tranſplanting at an early period, as the firſt or ſecond year, and lopping off all ſuch roots as have a tendency to ſtrike directly downwards, or to extend too much in a lateral direction, the plants being placed in a very rich ſoil, and kept at a good diſtance from each other, in

* Anderſon's Eſſays, vol. I.

order that they may not only grow ſtrongly, but that the ground between them may be rendered ſufficiently clean. It is remarked by the ingenious author juſt mentioned, "that in the winter ſucceeding the time the thorns have been tranſplanted, the earth between the rows ought to be dug over with the ſpade, taking care to go very cloſe to the rows, and to work with a very ſharp-edged tool, the operator always taking care to force his ſpade ſtraight down, with the back of the ſpade towards the thorns on each ſide of the row, as cloſe to it as poſſible, ſo as to cut the greateſt part of the lateral roots as near the body of the plants as may be, which will tend to make them branch out into ſtill more numerous ramifications. And if the ground be dug every winter afterwards, keeping at a little greater diſtance from the plant at each ſucceſſive digging, the roots will be kept at all times ſo ſhort, and their ramifications will be ſo numerous near the ſtem, that when they ſhall be lifted to be put into the hedge, they will not fail to be provided with ſuch an abundance of mouths to imbibe nouriſhment with, as to be in no danger of ſuffering much by that operation. If," continues he, "the ſoil of the nurſery be ſufficiently rich, and if the thorns have been tranſplanted while young, and early in winter, they will ruſh up chiefly in height, and ſend out but few lateral branches; which is a thing much to be wiſhed for in a nurſery; therefore care ought to be taken, when they are firſt tranſplanted, not to bruiſe or injure the ſtem of the plant, nor, on almoſt any account, to cut it over, unleſs the ſtem was before ſickly and ſtinted. Neither ought the upright ſhoots to be in any caſe ſhortened while in the nurſery: but to facilitate the operations between the rows, any ſtraggling ſide-branches that may ſpring out, ought to be cut off by the knife, or ſhears, at the beginning of winter.

"In every ſituation it will," he ſays, "be proper that the earth between the rows be ſtirred the firſt winter *by the ſpade;* but if the nurſery is of great extent, it may be afterwards done by means of the plough, with the utmoſt facility*."

Between the rows of quicks, where ſuch large ſpaces are left, various kinds of garden crops of the dwarf kind might be cultivated to advantage, ſuch as peas, turnips, ſpinach, and onions.

In collecting plants for forming thorn hedges, it has been generally the cuſtom to prefer ſuch as are very young and ſmall; but it is probably a much better, as well as more expeditious practice, where they can be procured, to have them

* Anderſon's Eſſays, vol. I.

much older and larger; as where the plants are of a conſiderable ſize, the hedge is not only much more readily formed, but the plants far leſs liable to be injured by the ſeverity of the winter ſeaſon, or the heat of the ſummer, and require a great deal leſs nurſing and protection, than where very young plants are made uſe of. In uſing plants of a large ſize, care ſhould, however, conſtantly be taken to have their roots preſerved as much as poſſible.

But whatever ſort or ſize of plants be employed, it is a neceſſary circumſtance to have all ſuch as are to be planted in the ſame fence, as nearly of the ſame vigour of growth and dimenſions as poſſible; as by proper attention in this reſpect the fence will be leſs in danger of having gaps and thin places formed in it, which muſt otherwiſe be the caſe from the inequality of the growth of different ſized plants. Beſides, by properly ſorting them, the farmer may be more enabled to adapt them to the particular circumſtances of the ſoil and ſituation of his land.

In preparing the quicks for planting, whatever the age or ſize may be, the roots ſhould be but very little touched by the knife, as it is always of advantage to the growth of the plants to have as many root fibres as poſſible remaining. Some part of the tops of ſuch plants ſhould, however, conſtantly be cut away, as from the injury which their roots ſuſtain in tranſplanting, they can ſeldom or ever ſupply a ſufficiency of nouriſhment to preſerve them from decay; in the older ſorts of plants more freedom in cutting may, however, be uſed, than in ſuch as are young.

The methods of planting live hedges vary conſiderably in different diſtricts, according to the cuſtoms and kinds of plants that are employed. In ſome caſes the plants are placed in an horizontal direction upon ſods turned mould-ſide upwards, in the face of *ditch-banks*, *mounds*, or *walls*, and covered up ſo as to have but a few inches of the plants without, in order that not more than one or two vigorous ſhoots may be thrown out by each. In this mode of planting, a good bed of mould ſhould be made for the reception of the roots of the plants, as well as covering them well up, as by this means they will be found to thrive much better.

It is remarked, on the authority of much experience, that "the proper method of planting this kind of hedge is, firſt to turn up a little of the earth from the place where the ditch is to be made, and lay it upon the bank reverſed, ſo as to form a bed for the plant about two inches thick above the ſolid ground. Upon this the thorns ſhould be laid nearly in a horizontal poſition, but inclining a little upward in the point, and having the ends of the ſtems juſt equal

with the face of the bank, or projecting beyond it very little, not more than half an inch. By this means, it is thought, the plants will ſend out only one or two ſhoots each, which will be the more vigorous, as there are ſo few of them. Where a greater number of ſhoots are ſent out in any plant, it will be proper," it is ſaid, "to prune away all the ſupernumeraries the firſt winter after planting, cutting them with a knife cloſe by the ſtem from which they ſpring: for it is the largeneſs of theſe original ſtamina of the hedge that will afterwards conſtitute its ſtrength, and not the number of ſmall ramifications, as is too generally imagined. If the ſhoots are numerous, they never acquire ſuch a degree of ſtrength as when there are fewer of them. But an eaſier way ſtill is, to rub off the ſupernumerary buds as ſoon as they begin to ſhoot in the ſpring. The plants being thus regularly laid, ſhould have their roots immediately covered with the beſt mould taken from the ſurface of the ditch; and the workmen ſhould take care to keep that good mould well back upon the bank, and rather behind the roots, leaving the breaſt of the bank to be made up by the leſs fertile earth taken from the bottom of the ditch. By this means the roots will have all the good earth about them, in which they will ſpread with freedom, and draw from it abundant nouriſhment; and the bad earth, which forms the breaſt of the bank, will produce much fewer weeds there than the good earth would have done, if it had been kept near the ſurface*."

As the hawthorn is, however, known to be impatient of much wet reſting near the roots, it ought never to be planted by the ſides or on the edges of ditches that have much ſtagnant water in them. The common method of planting quicks on the borders of ditches, near to the banks, is, indeed, in moſt caſes and ſituations, a bad practice; for whatever the nature of the ſoil may be, from the effects of the weather, and various other cauſes, the mould on their ſides is conſtantly removing itſelf, and leaving the roots of the plants expoſed and without ſupport.

In ſome diſtricts the banks on which the quicks are planted are made ſix feet wide at the bottom, three and a half at the top, and two feet in height. Some planters likewiſe prefer a ditch on each ſide, about three feet wide, and two feet deep, the ſides being made in a ſloping direction, and the bottoms not wider than ſix inches; while others only make one ditch, the earth on the oppoſite ſide being pared off to a ſlope. Some prefer earth mounds, planting the quicks upon a turned ſod, ſix inches high at their baſis, and on the edges of the

* Anderſon's Eſſays, vol. I.

ditches out of which they are raiſed. Where this mode is followed, it would, probably, be better to plant three ſods high, with the thickneſs of two ſurface ſods put under their roots. In this way the ſurface ſoil is in moſt caſes doubled, and in the thinner ſorts of ſoils nearly trebled, and a thick bed of the beſt earth is formed for the quicks to grow in.

Where young quicks are to be planted, it has been recommended that the bank ſhould be ſufficiently wide, for inſtance, not leſs than four feet wide at the top, that room may be allowed for planting two rows, at two feet or more aſunder, on the flat ſurface of the bank; care being taken that the roots be inſerted into the beſt mould, and that the ſides be ſloped in ſuch a manner as effectually to prevent their crumbling down, with a ditch on each ſide. And in order to prevent the depredations of cattle, thorns may be placed looſely in the ditches. This method ſaves the heavy expence of poſts and rails, or dead hedges, as cattle cannot ſtand nearer the ſtems of the quicks than ſix feet, which is ſufficient to prevent their being deſtroyed*. Mr. Billingſley has not, however, found this plan to ſucceed well in Somerſetſhire.

In making quick ſet hedges, Mr. Middleton likewiſe thinks it would, probably, be an improvement on the practice which has been generally followed, to put two rows of quicks in, at about a foot and a half or two feet from each other, which on growing up might be cut alternately every five or ſix years. The cut wood being by this means ten or twelve years old, and that left for a fence five or ſix; which would be ſufficient for a fence, as well as for the protection of the young ſhoots on one ſide from being cropped by cattle, while on the other they might be guarded by dead thorns thrown into the ditch. By this plan, hedges would, he ſuppoſes, become extremely profitable to the farmers. "But the method," ſays he, "above all others the beſt, if it ſhould be found to ſucceed, as it probably may, on a moiſt ſoil in a moiſt climate, is the grubbing of thorns five or ſix feet high, in copſes, &c. trimming the roots, and planting them cloſely on one ſpit of the beſt mould laid on the turf. This ſhould be taken from where the ditches are intended to be made, and chopped well to pieces. Then raiſe a bank on their roots round their ſtems at leaſt three feet high, and cut their tops level, two feet above the bank."

Of the advantage of this mode of making a quick fence at once, we are in ſome meaſure convinced by the trials we have made. It is neceſſary, however, to the complete ſucceſs of the plan, that the quicks be taken up with care, be

* Middleton's View of the Agriculture of Middleſex.

planted at a proper ſeaſon, and have a conſiderable depth of fine mould for the fibres of the roots to ſhoot into. A mixture of nearly equal parts of the ſcrapings of roads and good rich mould we have found them to grow by much the beſt in. If the ſeaſon be dry for ſome time after they have been planted, it will ſometimes be neceſſary to water the earth frequently about their roots.

Where the plants are put in upon banks, of whatever kind they may be, they ſhould always be placed ſufficiently back, in order to prevent their being carried away by the crumbling down of the ſides, and that they may be kept free from weeds, and the mould be better laid to them; inſtead of the common diſtance of four or five inches, it ſhould probably be ſeldom leſs than ten or twelve.

The large banks made by having double ditches are not, perhaps, to be adopted, but in very wet ſituations, as they take up a great deal of land without affording any advantage over the ſimple ditch. One ditch properly made will be enabled to carry off the water equally as well as two; nor is a double row of plants to be had recourſe to but in particular expoſed places; as a ſingle row, when attention is paid in putting them into the bank, will be quite ſufficient for the forming of a good hedge.

High banks, in whatever manner they may be made, ſeem only to be neceſſary in ſuch ſoils as are cold, wet, and ſubject to the ſtagnation of moiſture at particular ſeaſons.

Where ditches on the ſides are required, they ſhould conſtantly be made to ſlope down in ſuch a way as not to be wider than ſix inches at the bottom, as by this means the cattle will, in ſome meaſure, be prevented from walking in them, and eating the young ſhoots. Care ſhould likewiſe be taken in performing this buſineſs, that none of the ſtiff bad earth from the bottom of the ditches be thrown into the middle of the bank where the quicks are to be ſet, as it would retard their growth very materially, and, in ſome caſes, perhaps, entirely deſtroy them.

In other inſtances the quicks are planted on the plain ſurface without any bank being raiſed, a furrow being formed with a common plough, or a ſpit of earth dug out, in which the plants are placed in rather a ſlanting direction lengthways of the hedge, as well as againſt the upright ſide of the furrow or trench, at the diſtance of about four or five inches from each other, covering them with a little of the mould or earth that has been turned up on the other ſide, and treading it cloſely to their roots. The reſt of the looſe mould is generally, in this method of planting, afterwards laid cloſe to the plants by means of a ſpade.

Sometimes they are planted in the middle of the furrow or trench, the earth

being brought cloſe to them by the feet, and the raking of it up on each ſide. There are ſeveral other varieties in the modes of planting, but which, as they differ only in the manner of preparing the trench or furrow, and bringing the mould to the roots of the plants, do not require to be particularly deſcribed.

In the laſt method of planting, the young quicks are, in ſome places, put into holes made by a kind of dibble; but this is a practice that cannot be recommended, as the roots of the plants are not only too much confined, but the water, eſpecially in retentive ſtiff ſoils, is liable to ſtagnate in the holes, and prevent them from taking root quickly, by which they are often wholly deſtroyed.

The method of planting quick hedges upon the ſurface of the ground without much elevation, ſeems moſt ſuited to the drier kinds of ſoil, or ſuch as would be rendered too dry for their growth by having ditches cut on the ſides. But even in this way of proceeding, ſome kind of ridge, or elevation, ſhould be preſerved, that the rain water may not injure the young plants by ſtagnating too much about their roots.

In planting the quicks where the ground is raiſed, Mr. Billingſley adviſes a trench to be cut in the middle of the bank, into which the ſets are to be put at the diſtances of about three inches from each other, with their heads a little inclining. The roots muſt then be covered with a little of the beſt mould, and afterwards the whole trench be filled up with rotten dung or compoſt, only ſtrewing ſome more good mould on the ſurface *. But we are aſſured on the authority of much experience and obſervation, that it is infinitely better to place them five or ſix inches apart; and that it is ſeldom neceſſary to uſe dung or compoſt to the roots of them where the ſoil is tolerably good, and care is taken to apply it well to the roots, as it is apt to breed inſects, which are very injurious to the roots of the quicks.

The diſtances recommended above may, however, anſwer very well where the plants are ſmall, and the ſituation expoſed; but ſix or ſeven inches is better where the plants are of a good ſize, and the ſituation not too open. Indeed ſome adviſe them to be planted ſtill wider, as nine inches; and on good land, as much as a foot. Thick planting is, however, in general, to be preferred, eſpecially in expoſed places; as hedges, under ſuch circumſtances, for the moſt part thrive the beſt, eſpecially for a few years; and they may afterwards be prevented from being liable to choke and deſtroy each other by proper thinning. Where fencing wood is not eaſily procured, it may alſo ſometimes be a good practice to plant the quicks both in the face and top of the bank.

In expoſed ſituations it will always be neceſſary to ſhelter and protect the

* View of the Agriculture of Somerſetſhire.

young plants by means of ſome ſort of dead fence, ſuch as dead hedges, high banks, low walls, rails, or belts of planting. Where the firſt is employed, it ſhould be made about four inches diſtant from the outer edges of the bank. The hedges for this purpoſe are moſtly about two feet and half high, and made of wreath, or bruſh-wood, with a ſufficient number of ſtakes. This mode is not only much cheaper than that of poſts and rails, but likewiſe conſiderably better, on account of the ſhelter and warmth which it affords to the young plants.

In cold expoſed ſituations, Mr. Billingſley thinks that *two ſets* of dead fences may ſometimes be required for bringing the quicks to maturity; the expence of which he calculates in this way:—

	£.	s.	d.
Making the bank - - - - -	0	0	9
Quick ſets, eighty in a rope - - - -	0	0	9
Planting and dunging - - - -	0	0	2
Two dead hedges - - - - -	0	2	5
Making two dead fences - - - -	0	0	5
	0	4	6
Weeding plants for three years - - - -	0	0	3
Two additional dead hedges - - - -	0	2	10
	£.0	7	7*

It is obſerved that "one waggon-load of writh will coſt 17*s.* 6*d.* and make about fifteen rope of ſingle hedge. And that the old wood will pay for ſundry repairs of the hedges, ariſing from different accidents†."

In low wet ſituations it would probably be the cheapeſt method to have recourſe to ſhort willow ſtakes, which might be put into the edge of the bank in a ſloping direction outwards, and to be bound together by means of an eddering at the top. In this way the quicks would ſoon be protected by means of a living fence. In the Devonſhire mode of planting on a high bank, ſomething of this ſort is practiſed for protecting the young quicks on each ſide.

High banks are ſometimes raiſed with ſods and earth in expoſed ſituations for the purpoſe of protecting young plants. Where ſtones are plentiful, and the ſods

* The price of hazel coppice-wood and labour being conſiderably advanced, one ſhilling per rope, it is obſerved, muſt now be added to this eſtimate.

† Agricultural Survey of the County of Somerſet.

made on the ſurface, walls about two feet high are raiſed for the ſame purpoſe. Rails can be uſed where protection from cattle is only required. If belts of planting be had recourſe to with this intention, the moſt hardy ſorts of trees or ſhrubs ſhould be placed on the outſide, and ſuch as grow with more difficulty within them.

Quicks for planting ought, as we have already obſerved, to be taken from ſuch nurſeries as have been made on good ſoils; and ſhould be ſtraight in their growth, with clean ſtrong *ſtems*, and have been twice tranſplanted from the ſeed bed, being about five years' growth from the haw. This ſort of quicks have generally a great number of roots, which, as has been ſhewn, renders them more certain of ſucceeding on being planted out. It is well obſerved by Mr. Middleton, that if quickſets are bought after they are taken up, the purchaſers ſhould beware that they are not thoſe drawn up by the roots on the commons; that is, wild quicks; as they are ſtunted plants which canker and never grow well. It is a cuſtom with thoſe people who live near to, and on the commons, when there is an incloſure, to collect the wild quicks, cut the tops off within only a few inches of the ſtems, and ſell the roots. They commonly diſpoſe of them at a much lower price than the nurſery-men, but they will never make a good fence*.

Theſe fences are frequently prevented from ſucceeding ſo well as they might otherwiſe do, eſpecially where the quicks are young, by the bottoms being neglected and not kept ſufficiently clean. They ſhould be well weeded and hoed as often as is neceſſary, and every ſort of rubbiſh be carefully removed from about their roots and ſtems. This may be performed in the moſt eaſy and beneficial manner, by firſt looſening the earth on the ſides of the plants by means of a ſort of ſpud or three-pronged fork, as the roots are thus not ſo liable to be injured, while the weeds are more readily removed. In young hedges, this buſineſs ſhould always be done as early as poſſible in the ſpring, in order that the weeds may be prevented from ſeeding, as well as getting too great a head. In the cleaning of hedges, when ſituated in the banks of ditches, it is a common practice to pare the ſurface off thinly by a ſpade; but which, though it renders it clean for the time, not only expoſes the banks more to the mouldering effects of the air and froſts, but in time ſo reduces them that the roots of the plants are left expoſed, and the ditches ſo choaked up as to prevent the water from getting readily away. Where the ſhovelings from the ditches in road ſides, or other places, are laid up to the roots of the plants, which is often done when they are put in on high banks, great care ſhould always be taken to lay them up and ſecure them well, by

* General View of the Agriculture of Middleſex.

placing tough ſods for them to reſt againſt; as where they are only bet or plaſtered up by the ſpade, they are ſoon apt to crumble and carry down with them large parts of the banks, by which more injury than good is often done.

The cropping of ſheep and cattle ought alſo conſtantly to be well guarded againſt; but where this has happened, the bruiſed ſhoot ſhould always be cut down within an inch or two of the ground. The mould ſhould, likewiſe, be looſened and drawn up a little to the roots of the plants, by which they are made to grow not only more vigorouſly, but to ſend out more numerous ſhoots.

All the operations for the above purpoſes ſhould, probably, be performed much more frequently than is the common practice among farmers; or than has been generally ſuppoſed; as by ſuch means the general growth of the hedges will not only be encouraged, but more numerous ſhoots be ſent off from the bottom ſtems, and thus render them thicker.

In regard to the propriety of planting timber trees in hedge-rows, there is ſome difference of opinion; we apprehend, however, that it cannot in general be admitted to any very great extent, though it ought not probably to be totally neglected. When planted in this way, the droppings of large trees do not only frequently deſtroy the young thorn plants, and thereby cauſe holes or vacancies in the hedges, but conſiderably injure different ſorts of crops, eſpecially thoſe of the corn and graſs kinds.

Where hedge-row planting is, however, wholly diſregarded, there is a nakedneſs, as well as wildneſs of proſpect, which is highly diſguſting to the eye of the traveller. Beſides, as in this way timber trees are raiſed with but little expence, or trouble, there would ſeem to be conſiderable loſs to the proprietors of land, as well as farmers, in not paying ſome attention to ſuch methods of raiſing uſeful and neceſſary timber.

When this method is followed, and for planting in the angles, corners, and other waſte ſpots of fields, the Scotch fir, the beech, larch, ſycamore, and birch, as being hardy trees, are the moſt proper. The aſh may, likewiſe, be made uſe of in ſome caſes without any inconvenience. It is, however, thought by ſome that timber is raiſed at a greater expence in this way than any other, when all the injury they do is taken into the account.

The common cuſtom of cutting and clipping young thorn and other quick hedges every year, however advantageous it may be conſidered in point of the appearance of the fence, is highly prejudicial to the growth of the quicks or other plants, keeping them ſmall and weak in the ſtems, and rendering the hedges, as they grow old, open at the bottoms. On the contrary, thoſe that are left to

themſelves become ſtrong in the ſtems, and have large ſide branches, which, by interweaving with one another, render the hedge thick and impenetrable. Thoſe that are cut at proper intervals, as about every ſeven or eight years, have generally a conſiderable ſuperiority over thoſe which have been clipped from the time they were firſt planted. Beſides, there is a conſiderable ſaving of labour, and the hedges are far more profitable.

When pruning is neceſſary, it may be performed in a neat and expeditious manner, by means of a pair of pruning ſhears; the beſt ſort of which are thoſe conſtructed with a ſtrong ſharp blade, about ſix or eight inches in length, moving between two pieces of iron, with ſquare edges as cheeks. The handles ſhould be a good length, in order to give the operator ſufficient command in cutting the upper parts of the hedge, and the higher one three or four inches longer than the lower*. Some workmen, however, prefer for this purpoſe an inſtrument made ſomewhat in the form of a reaping-hook, and extremely ſharp, to which is fixed a handle of about two feet, or two feet and an half long. In the hands of an expert workman this, too, is a very good implement.

The time at which hedges are uſually cut is the ſummer, which, from the ſtate of vegetation, is evidently the moſt improper that can be choſen, as the plants by being cut, while full of ſap or juice, cannot but be greatly injured. The moſt ſuitable period for this buſineſs would ſeem to be that of the latter part of autumn, when the growth of the plants is in a declining, or the leaſt vigorous ſtate.

In reſpect to the manner of cutting them, various methods are adopted and practiſed, but that which ſeems to give them the moſt uſeful form, is by letting them have a kind of ſloping or narrowing direction on both ſides from the bottom to the top, as by ſuch a mode the thickeſt part will be in the bottom where it is the moſt wanted. The reverſe of this is, however, frequently the caſe in cut or clipped hedges.

The buſineſs of clipping or pruning hedges ſhould not, as has been juſt obſerved, be performed too frequently, as by ſuch means they are liable to become thin in the bottoms, a defect which can only be effectually removed by cutting the plants down cloſe to the ground. For ſeveral years after a hedge has been planted it ſhould, therefore, probably undergo little cutting, except in the lateral branches that may ſpread out; in the taking off of which, attention ſhould always be had to draw it to a ridge-like form, or make it the narroweſt at the top, as has been ſuggeſted above.

On theſe points it has been remarked, by a very able and experienced writer.

* General View of the Agriculture of Northumberland.

that " nothing can be more prejudicial to a young hedge than an injudicious application of the ſciſſars; and that although it be extremely common to clip the top of a hedge for a few years at firſt, even where it is to be diſcontinued ever afterwards, yet it would hardly be poſſible," he thinks, " to contrive a practice that would be more prejudicial to it than this is. The chief properties that conſtitute the excellence of a hedge, are ſtrength and cloſeneſs. Now," ſays he, " a hedge can be made ſtrong by nothing elſe than the vigour and ſize of the principal ſtems of which it is compoſed. But it is evident that, by cutting the tops of all the radical ſhoots, each of them is forced to ſend out a great many ſmaller ones, as in a pollard-tree; and each of theſe ſmall ſtems being cut again and again, are divided into ſtill ſmaller and more numerous ramifications, till their number is increaſed to ſuch a degree, and their ſize, of conſequence, ſo much diminiſhed, that the hedge may be ſaid to conſiſt entirely of an infinite number of ſmall twigs cloſely interwoven with one another, which have not ſufficient ſtrength to make any conſiderable reſiſtance to a furious bull, or other ſtrong animal, who will eaſily break through any part of ſuch a hedge that he may chance to attack, however cloſe it may appear to be. But if, inſtead of being cut on the top, the thorn be allowed to advance upwards without any interruption, its ſtem, like that of any other tree, will continue to increaſe in ſize and ſtrength, and, in a ſhort time, become ſo large as to be able to reſiſt the whole force of any animal that we may have occaſion to fear. They even in time become ſo large, as to occupy almoſt the whole ſpace that was originally left between the plants, ſo as to form," he ſays, " a ſolid vegetable wall (if he may uſe that expreſſion), which it is almoſt impoſſible for any force to overturn. It is therefore obvious," he thinks, " that cutting the top of a hedge when young, tends greatly to diminiſh the ſtrength of it*."

He further obſerves, that it will, perhaps, be a more difficult taſk to convince the reader, that this practice likewiſe tends to diminiſh the thickneſs of the hedge; although he flatters himſelf that he ſhall be able to demonſtrate this as clearly as the other. " When," ſays he, " the principal ſtem of any tree is cut over, the ſap that would have gone to increaſe the ſize of its top, being ſtopt in its aſcent, forces out a great many ſhoots all round the ſtem, immediately below the place where it has been cut over. And when this is the caſe with a hedge, the number of ſhoots that are crowded together, draw the ſap ſo powerfully to that place, and occaſion ſuch a deep ſhade below it, that all the horizontal ſhoots

* Anderſon's Eſſays, vol. I.

which had ſprung out from the ſtem, near the roots, being deprived of their nouriſhment, and the influences of the air, are checked in their growth, and in a ſhort time totally periſh, leaving the ſtem at the root quite naked and bare. And as there are from that period no branches ſpringing immediately from the under-part of the ſtem to detain the ſap in its paſſage, and make that part of it increaſe in ſize, it there continues ſmall and weakly; while the top, continuing to advance with luxuriance, becomes ſo large and weighty, as to be with difficulty ſupported by theſe ſmall naked ſhanks, which gradually become barer and barer every year. But every one knows," he ſays, "that if the bottom of a hedge be open, it is of very little conſequence whether it be cloſe above or not: and he leaves it to be determined by experience, whether this is not, in general, the condition of hedges which have been clipped in the top when young, eſpecially in thoſe caſes where the hedge has made vigorous ſhoots the firſt year. And if it ſhall be found that this is in general the caſe, we muſt conclude," he thinks, "that the practice here reprehended tends to make the hedge thinner, as well as weaker, than it would have been if that operation had been entirely omitted. But if an hedge is allowed to advance in height, without being cut in the top, the ſmall branches that ſpring out near the root, not being ſtarved by the extraordinary ſuction, or ſuffocated by the ſhade of too luxuriant branches above them, continue to live, and detain a part of the ſap, ſo as to make the under part of the ſtem ſtill continue to increaſe in ſize and ſtrength, and be well able to ſupport the ſmall top that it thus acquires. And if the moſt luxuriant ſide-branches that may ſpring out above, are from time to time pruned away, ſo as not to be allowed to overſhade thoſe that may be below, theſe laſt will continue to grow as long as the hedge exiſts. And as, by this management, there will be but few ſide branches of any conſiderable ſize, the principal ſtems will advance with very great vigour, gradually tapering from the root upwards. He cannot," he thinks, "be too particular in adviſing the huſbandman to beſtow his attention chiefly to the proper formation of the upright ſtems of the hedge, becauſe upon this the whole future ſtrength of the hedge muſt," he ſuppoſes, "entirely depend: and if theſe are once rightly formed, it will be an eaſy matter to give it every quality that we could wiſh for in a hedge. For, if theſe ſtrong ſtems ſhould be even entirely deſtitute of ſmall branches, abundance of them may be made to puſh out whenever it ſhall be thought neceſſary, by only making a ſlight wound in the naked ſtem, wherever you deſire that young branches ſhould appear: for, below every ſuch wound, a number of ſmall ſhoots will ſpring forth the enſuing ſeaſon; the points of which being cut off, a ſtill greater num-

ber of ſmall twigs will be ſent out, which, by being frequently cut, will, in a ſhort time, form a covering as cloſe as could be deſired. The truth of this reaſoning," he ſays, " he experienced at a very early period of his life; for, having then had occaſion to dreſs a garden that was ſurrounded by an old hedge, which had always been allowed to grow as nature prompted, never ſeemingly having been touched either by knife or ſciſſars, he found the branches ſtraggling very far on every ſide; all of which," he ſays, " he cauſed to be cut off quite cloſe by the upright ſtems, which then were left entirely naked, and appeared like as many may-poles placed beſide one another. But by cutting a good many ſlight notches all along theſe ſtems, at the diſtance of a few inches from one another, they were in one year entirely covered with young ſhoots; which ſmall branches, by being cut once or twice in one ſeaſon, put out ſuch a number of ſmaller ramifications, as in a ſhort time formed a covering ſo very cloſe, that it was hardly poſſible to ſee an object through it in any part. Nor did he ever in his life ſee a hedge that, either for ſtrength or beauty, could be compared with this one. Many of the ſtems were ſix or eight inches in diameter; and they grew ſo cloſe to one another, that no animal larger than a ſmall bird could poſſibly have penetrated it.

" From theſe obſervations," he thinks, " it will appear evident, that if we wiſh to have a good hedge, either in reſpect of ſtrength or cloſeneſs, it is of importance never to ſhorten the top ſhoots, at leaſt while it is young; but it is always of uſe to prune the ſides, cutting off all the lateral ſhoots with the ſciſſars quite cloſe to the upright ſtems, after the firſt year's growth. And if, after the growth of the ſecond year, it ſhould happen that too many ſhoots have ſprung out at the top of the firſt year's ſhoots (which very frequently is the caſe), theſe ſupernumeraries ſhould be cautiouſly pruned away with a knife; taking out all the ſtrong upright growing branches, excepting one for a ſtem; being always particularly careful to cut them away quite cloſe to the ſtem from which they ſpring: for if this caution were," he ſays, " neglected, a greater number of ſhoots would ſpring out from the wound, and the malady be increaſed rather than diminiſhed*."

Theſe circumſtances being properly attended to, the hedge will, it is conceived, need no farther care afterwards, but to be defended from cattle, kept free of weeds, and clipped in the ſides once a-year for ſome time; care being always taken at each clipping to go as cloſe to the laſt as can eaſily be done, eſpecially towards the upper parts of the hedge; but towards the bottom, the ſhoots may be allowed to remain gradually a little longer, ſo as to make the ſide

* Anderſon's Eſſays, vol. I.

of the hedge to ſlope inwards a little above, which gives to the under-twigs a freſhneſs they could not otherwiſe be made to attain. In firſt performing this operation, particular attention ſhould be paid to clip it as near to the upright ſtems as poſſible; for, as the ſide branches muſt always extend a little farther at every cutting, if this caution be neglected the lateral ſhanks will, in time, become naked, and diſagreeable voids of courſe formed in the ſurface of the hedge.

By attending to theſe rules for a few years, he ſuppoſes the hedge, while it advances in height, will become as cloſe in the ſides as could be wiſhed for; and that although the clipping of the ſides ſhould be diſcontinued after a ſhort time, it will be in no danger of running into great diſorder; for, as the vigour of the ſide ſhoots will have been much diminiſhed by having been ſo frequently divided, none of them will afterwards advance to ſuch a diſtance as to deform or hurt the hedge; ſo that, he thinks, the operation may be diſcontinued, unleſs in caſes where great neatneſs is wanted.

In comparing quickſet hedges with walled fences, Mr. Billingſley remarks, that "they are beautiful to the eye, and that if the climate, quality, and depth of ſoil, be ſuch as to throw out a vigorous ſhoot, and minute attention be paid to them in their infancy, they are leſs expenſive, and at the end of fourteen years will yield a ſufficient produce when cut down and plaſhed to pay all the expences incurred in the firſt making; and that this cutting may be repeated every twelve or fourteen years without injury to the ſtocks*."

He alſo judiciouſly reminds the farmer, that the proper time for plaſhing his hedges is when the land is to be ploughed, or, if it be paſture, when the crop is to ſtand for hay. By taking advantage of the ground being in theſe ſituations, the miſchief produced by cattle will be perfectly provided againſt.

In the management of old hedges, ſeveral different methods are employed. Where they become much ſtinted, from the badneſs of the ſoil in which they are planted, or other ſimilar cauſes, the moſt ready and effectual mode of recovering them is probably to cut the plants of which they are compoſed down pretty cloſe to the ſurface of the ground in the latter end of autumn, or the early part of the ſpring; afterwards keeping them perfectly free from weeds, and managing them in the way that has been directed above. And in the ſpring, when the young buds begin to appear, it is adviſed, by an experienced writer, to attend carefully to the ſtumps, in order to rub off all the buds, ex-

* Agricultural Report of the County of Somerſet.

cept one or two of the ſtrongeſt, which are beſt placed for ſhoots; as where the whole number are ſuffered to remain and grow, they ſoon become weak and reſtricted in their growth, as in the former caſe. For want of due attention to this, hedges that have been ſeveral times cut over, are frequently quite ſpoiled. Where the fields on the ſides of hedges, treated in this way, are in a ſtate of tillage, they are likewiſe conſtantly found to thrive better than where that is not the caſe, eſpecially if they have been planted on the plain ſurface, or only on a ſlight bank *.

In other inſtances, hedges, when they have had about eight or ten years' growth, are headed down to the height of two or three feet. This is, however, by no means a good practice, as in conſequence of the young ſhoots ſpringing from the tops of the ſtems, the lower parts of the hedge in a few years not only become thin, bare, and full of openings, many of the ſtems being dead, but from their ſhooting out ſo buſhy at the top, they are apt to ſmother all below. After the hedge has a ſecond time grown large, the ſhoots that ſpring from the tops of the old ſtems are, however, again ſubjected to the axe, a few being left merely for the purpoſe of nicking or laying down even with the top of the hedge. Such a fence as this never looks well, nor is it ſufficient, without dead wood being put in the bottom, to prevent ſheep from running through it, by which all the young ſhoots are either broken down or killed.

Another method which is practiſed by ſome farmers, and which is undoubtedly better than that which we have juſt deſcribed, is that of laying the hedges. This is, however, a mode chiefly employed when they are not very old, but thin and full of gaps or ſpaces, where there are no plants, and is done by cutting off the ſtems of the quicks cloſe to the ground, leaving only one in the ſpace of about every foot, which is trimmed nearly to the top, nicked, and then laid down and interwoven in an horizontal poſition, either with ſuch living ſtakes as may have been left, or dead ones ſet into the ground at about the diſtance of a foot and half from each other. The top of the hedge is afterwards bound with ſtraight branches of hazel, or other ſmall wood, twiſted together in ſuch a way as to incloſe each ſtake, by which means they are ſupported, and the layers kept in their proper ſituation. From the tops of the ſtems which have been thus cut, and thoſe which are nicked, in a couple of years an abundance of young ſhoots ariſe, by which an excellent thick hedge is formed. In per-

* Anderſon's Eſſays, vol. I.

forming this buſineſs the operator ſhould, however, be careful to fill up the places very well where the hollows or void ſpaces formerly were, by laying them more cloſely down, and putting in proper ſtakes. In making this ſort of hedges the perſons employed begin at one end, and proceed regularly forward till the whole is laid down to the proper height, which, by a good workman, is very readily accompliſhed. In ſuitable ſituations, ſtakes of willow or alder may be employed with advantage, as they frequently take root and grow well. This is an extremely good method of renewing an old hedge under ſuch circumſtances. The principal objection to the above plan is, that in the courſe of a few years the layers, eſpecially if they be thick or ſtrong ones, die, and the young wood underneath is much checked and injured in its growth, by the droppings from them and the decayed bindings.

But the beſt, and probably the moſt advantageous method of renewing an old hedge for the farmer, particularly where it can be protected from cattle, is that of heading the whole down to within a few inches of the ground or bank. By this means in a couple of years an aſtoniſhing quantity of young wood is produced, ſo as to form a hedge that can ſcarcely be ſeen through. Where there are ditches, the ſcourings may be thrown up to the roots, which ſerve as a ſort of earthing up to the plants, and make them grow with greater vigour and ſtrength. By this method, however, if the hedge be old, many of the larger thorns will frequently die. In laying the earth up to the roots great care ſhould be taken, as injury is often done by overloading them, whole fences being ſometimes deſtroyed in that way. Where, however, the plants are cut cloſe down, and ſuitable earth applied over them, a great number of vigorous ſhoots are not only ſent out from each ſtem, but from their being in the ground frequently take root, and become independent plants, by which the bottom parts of the hedges become extremely thick and cloſe. A ſlight ſtake and edder fence muſt be made in order to preſerve the ſhoots from being cropped and deſtroyed. Part of the wood which has been cut out of the hedge ſerves for this purpoſe; the remainder being either employed in making of other fences, or made into bavins for the uſe of bakers, &c. * by which a conſiderable profit is immediately produced. By this method too, where there are ditches, the ſides of the banks are much preſerved from being deſtroyed by cattle, as the plants ſhoot out both on the ſides and the tops of them.

This ſeems, therefore, to be a much better practice than that of making a

* In London theſe bavins generally ſell at about a guinea a hundred, delivered.

ſolid face to the bank, by means of either ſods or ſtones, as the young wood is not prevented from growing on the ſides of the banks, or the banks ſo liable to be thrown down by animals. Beſides, there is conſiderably more produce of wood from the hedge, which in many ſituations is an object of great importance. Where hedges grow thin at the bottom, Mr. Harper, an ingenious Lancaſhire farmer, was accuſtomed to follow this practice: " He cut the wood very low, leaving the young and vigorous ſhoots; after cutting away the old wood, he took a hand-ſaw, and cut away again that part of the old ſtump, ſo far as was ſhaken by the hatchet in the firſt ſeparation, and ſew the top level, ſo that the water might not remain upon it. By this practice," he ſays," the ſhoots will grow ſtronger, and more in number, in one year, than they would by the common practice in three years. When the ſhoots are half a yard, or two feet long, he bends the young ſhoots down, and, where room permits, makes a hole in the bank with a ſhovel, in which the ſhoots are cloſely tied down with hooked ſticks, and covered up again with earth, when theſe young branches, with a little nurſing, will, by taking root afreſh, form a new hedge*." But from the great trouble and conſequent expence of this method, it can probably only be had recourſe to in particular inſtances. There can, however, be no doubt but that the leſs injury there is done in the cutting of the plants, the better they will throw out young ſhoots, and alſo the leſs liable they will be to decay from the ſtagnation of moiſture upon them.

It has been ſuggeſted by ſome planters, that quick hedges may much more readily be raiſed by the warmth and ſhelter of low ſtone walls; they have therefore propoſed the making of both a wall and a hedge; to which there can certainly be only one material objection, which is that of the expence. Where there are plenty of ſtones, and the ſituation is elevated, cold, and expoſed, ſuch a plan may be deſerving of attention.

The wall in theſe caſes ſhould be about four feet and an half high; and be turfed on the top; the quicks being planted on a low bank raiſed under it, and a dead fence made on the inſide, in order to afford them protection †. After the quicks

* Agricultural Survey of the County of Lancaſter.

† The expences of this as ſtated by Mr. Billingſley, in the Agricultural Report of the County of Somerſet, ſtand thus:

	£.	s.	d.
Building four feet and a half of wall, ſtones and halling included	0	6	0
Turfing - - - - -	0	0	2
Making bank and planting quick - - -	0	0	4
Carried forward, -	0	6	6

are grown up, the wall may be pulled down, and the materials be converted to other uſes.

There is another mode of fencing, which is ſometimes adopted in expoſed ſituations, where the ſoil is ſufficiently good, which is that of planting full-grown ſloe, or black-thorn, pretty thick, and mixing with them hazel, withey, the large briar, &c. cutting off their tops to the height of about three feet, on a bank raiſed from two to three feet, with ditches ſufficiently deep. This is not, however, a method to be recommended, except in ſuch kinds of bleak ſituations. The black-thorn abounds in moſt places, and may therefore be eaſily procured. The loppings of the plants may be ſtuck along the ſide of the bank, being well ſecured by ſuitable ſtakes, ſo as to guard the ſtocks from being injured by cattle or ſheep. This ſort of fence is made at an extremely cheap rate, from the low price of the plants; and from their throwing out ſhoots very extenſively, with the aſſiſtance of the briar, in ſuch ſituations, ſometimes ſoon form a cloſe and impervious hedge.

In this way this ſort of thorn does not, indeed, grow to any great height, but ſufficient with the bank for the purpoſes of confining and ſheltering animals. If the fields be in a ſtate of arable cultivation, the ditches, when made of a good depth, will prevent the running of the roots from obſtructing the plough * †.

	£.	s.	d.
Brought forward, -	0	6	6
Sets - - - - - -	0	0	8
One dead fence on the inſide - - -	0	1	2
Weeding - - - - -	0	0	2
	0	8	6
From which deduct the value of the ſtones, at three pence per cart-load	0	1	6
	0	7	0

* Agricultural Report of the County of Somerſet.

† One good waggon-load of theſe plants, it is obſerved in the ſame work, will be ſufficient for twelve rope. The coſt is thus eſtimated:

	£.	s.	d.	
Making the bank - - - -	0	1	0	per rope.
Digging up and planting - - - -	0	1	6	
Carriage of plants - - - - -	0	0	9	
	0	3	3	

In reſpect to the carriage, the price muſt vary according to the diſtance, and other circumſtances.

Where land is much expoſed to the ſea air, it is found extremely difficult to raiſe quick fences upon it as this air; probably from the ſuperabundant quantity of muriatic acid which it conveys, and which is readily ſeparated from it, on account of its looſe ſtate of combination, is highly deſtructive to the white-thorn, and ſeveral other plants employed in the making of hedges. The beſt mode in ſuch ſituations is probably that of planting beech, as it ſeems, in a great meaſure, proof againſt the injurious operation of this kind of air. The bank on which it is to be planted ſhould be ſix or ſeven feet high, and four or five in width at the top; on which the young beech plants are to be put in, in two or three rows, at about the diſtance of a foot from each other, and ſufficiently thick in the rows. In moſt caſes no ditch is made; but in ſome inſtances the banks, or mounds, are prevented from crumbling down either by a low ſtone wall, or ſome other ſuitable means. The growth of theſe plants is rapid, they therefore ſoon form not merely an excellent and beautiful fence, but one that is highly advantageous both in reſpect to the ſhelter which it affords, from the leaves being retained to a late period, and the annual profit that may be derived from it; as when at maturity one of the rows may be alternately cut and converted to various uſes, and the others plaſhed or trimmed ſo as to yield much wood for fuel or other purpoſes. This ſort of hedge has, however, one great diſadvantage, which is that of requiring ſo large a quantity of earth for the making of the bank.

In ſituations ſuch as the above, furze may often be made uſe of for a fence, as the young furze grows quickly, and without much difficulty, if they be raiſed by ſowing the ſeeds thickly upon pretty high and broad banks, with ditches on the ſides. As the old parts of furze ſoon die away, it will always be neceſſary to guard againſt the thinneſs produced in this way, which may probably be beſt done by cutting the plants cloſe down firſt on one ſide, and then on the other, every two or three years, to admit of which is the principal deſign of ſuch a broad bank; and thus have a fence on one ſide or the other conſtantly in perfection. The cuttings obtained in this manner may in ſituations where fodder is ſcarce be made uſe of, when bruiſed, as an article of food for animals. This mode of training furze fences is, however, objectionable, not only as waſting a great deal of ground, but as being liable, from the ſeeds being ſcattered over the incloſures by the wind, to fill them full of this almoſt eradicable plant.

In planting hedges of willow and other aquatic plants, the ground ſhould always be made as mellow and friable as poſſible, and the ſhoots to be em-

ployed of two or three years' growth, and freſh cut off at the time of uſing them. They are then to be put into a narrow ridge of ground, prepared for them, at the diſtance of eight or ten inches from each other, the tops being bent different ways, and plaited firmly together ſo as to make a fence *. The grey willow is probably the beſt kind for this purpoſe. In ſome inſtances the ſweet-briar may probably be mixed with the willow to advantage.

Whatever ſort of fence is made in ſuch ſituations, it is perhaps a good practice to raiſe a pretty high bank with a ditch on each ſide, and in ſome caſes to plant hedges in each face of the bank, ſo that it may afford ſhelter to them while they get up, and that afterwards one may protect the other, and render their growth more rapid.

The filling up the deficiency of hedges, of whatever kind they may be, with dead materials, though a very common practice, ſhould be had recourſe to as ſeldom as poſſible, as the hedges are by this means not only prevented from throwing out young ſhoots to fill themſelves up, but the dead materials when they begin to decay leave larger openings than exiſted before they were introduced. Where hedges are diſpoſed to become moſſy, the mixing of lime, aſhes, or ſuch-like ſubſtances, with the mould of the banks, may frequently be of conſiderable utility in removing it.

In ſome ſituations, hedges made ſolely of dead materials are had recourſe to as a means of dividing incloſures. This is, however, a practice which, from the great expence of forming them, their conſtant tendency to decay, and the neceſſity they have for annual repairs †, ſhould never be adopted when there is a poſſibility of raiſing living fences, except indeed when they are merely uſed, as has been already noticed, by way of a protection to young quick hedges. For the former purpoſe, the longeſt part of the cuttings from living fences, or other places, are wattled by means of ſtakes driven into the ground at ſixteen or eighteen inches diſtance from each other, and bound on the top by means of aſh, hazel, or willow bindings. This is termed a *ſtake* and *band* hedge. With the latter intention, the ſhorter and more buſhy ſort of cuttings are generally employed, and either ſtuck into the ground on the ſurface, the ſide or top of the bank in a ſlanting direction lengthways of the fence, and inclining a little towards the incloſure, or made into a low ſtake and band hedge, in the way deſcribed above. In making this ſort of fence, great care ſhould be taken not to

* Anderſon's Eſſays, vol. I.

† Theſe, in ſome inſtances, amount to from a ſixth to an eighth or tenth part of the rent.

place the dead materials too near the living plants, as by such inattention they are frequently much injured and retarded in their growth, from the falling down of the rotten and decayed parts of the wood.

DITCHES.

These are constructed with different intentions, being sometimes formed only as a part of a fence, or as a drain, while at others they serve equally the purposes of drainage and inclosure. But for whatever purposes they are designed, they should always be formed with sloping sides, as when they are cut perpendicularly down, the surface of the land, or the sides, is liable to give way and fill them up. In forming ditches, regard is likewise necessary to the peculiarity of the soils, and the nature of their drainage, in order that they may be dug in a suitable manner in respect to depth, and the direction most convenient for conveying away the water; much mischief being frequently occasioned by its remaining in a stagnant state in them, from these circumstances not being properly attended to.

When ditches are made for the purpose of fences, they should be sufficiently wide to prevent animals from getting over them, and be more than usual sloped in the banks, that cattle may not so readily poach them in. In general, from seven or eight to ten feet in width, and from three to five feet in depth, constitute a pretty secure fence. Ditches of this sort ought also to be more frequently cleaned out, and have their sides well pared down, than is the general custom among farmers; as by these means the grounds on each side, and in the neighbourhood of them, are more effectually drained, and the water rendered much less stagnant and pernicious to the health of the inhabitants of the districts in which water ditches abound. The earthy materials obtained by this means may often be converted to a very useful compost manure for various kinds of grass-lands, by being well mixed with a suitable portion of rotten dung.

Care should likewise be taken that they have proper communications, with suitable outlets, as the brooks or rivers in the vicinity of them, as by a neglect of this much mischief is frequently produced.

In wet marshy situations, large spaces of ground are frequently left between ditches which act as drains. Under these circumstances, perhaps, the best and most profitable method that can be adopted, is that of planting them with osiers,

PLATE XXXIV.

Gates and Stiles.

[*To face Page* 143.]

Fig. 1. A common *ſwing-gate* with ſimple croſs bar or brace.

Fig. 2. The common upright *ſwing-gate*, which is more cloſe than the former.

Fig. 3. An improved upright *ſwing-gate*, which, at the ſame time that it is more cloſe, is likewiſe more ſtrong and ornamental than either of the others.

Fig. 4. Is a *ſwing-gate* on an improved principle: *a* the projection on the fore part of the *bar-tree*, riſing nine inches, on which the lower end of the diagonal bar, paſſing upwards, reſts; *b b* the diagonal bar, through which the three middle horizontal bars paſs; *c c* a perpendicular bar fixed into the uppermoſt bar ſix inches from the inſertion of the diagonal one at *d*, and into the lowermoſt at *e*; *f* the ſpring on the fore-tree, by which it faſtens. This is a ſtrong, uſeful gate.

Fig. 5. A double gate of the ſame ſort; *a a a* three croſs bars; *b* the diagonal bar, as in the former. The objection to this conſtruction is the great number of joints.

Fig. 6. Is a gate moving on the centre with the appearance of two gates. This takes up much room, but is ornamental.

Fig. 7. *Common folding gate*, very uſeful in many caſes.

Fig. 8. A cloſe folding gate.

Fig. 9. Common ſtile. *Fig.* 10. Another common ſtile. *Fig.* 11. The *wicket ſtile*. *Fig.* 12. The ſimple ſtone ſtile. *Fig.* 13. The *Corniſh ſtile*. *Fig.* 14. An improved ſtile with rail.

Fig. 15. Repreſents a ſimple method, deſcribed in the Northumberland Agricultural Report, of fixing the hooks and eyes in hanging-gates ſo as to ſhut in every poſition. The poſts being ſet perpendicular, a plumb-line, *a b*, is to be drawn on it: on this line, at a ſuitable height, place the hook *c*, ſo as to project three inches and a half, and, at a proper diſtance below, put in the hook *d* an inch and a half on one ſide of the line, and ſo as to project two inches; then place the top loop or eye two inches from the *haw tree*, and the bottom loop three inches and a half. For, if the weight of the gate be repreſented by the line *a b*, by the reſolution of forces this is reſolvable into other two *c c*, and *d e*, the former repreſenting that part of the weight which preſſes in a perpendicular poſition, and the latter that which preſſes in a horizontal direction, and gives the gate a tendency to ſhut.

GATES & STILES.

Fig. 9.

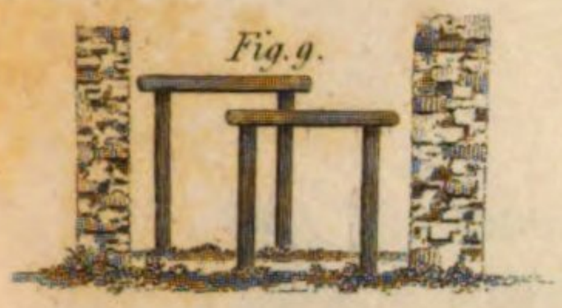


Fig. 10.

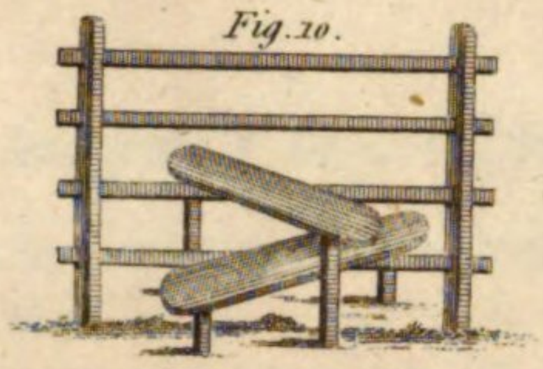


Fig. 11.

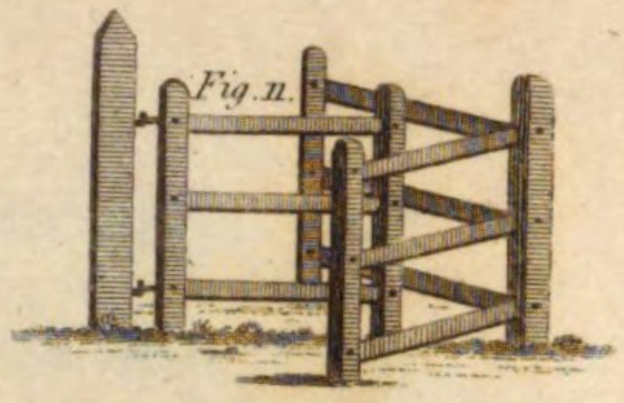


Fig. 2.

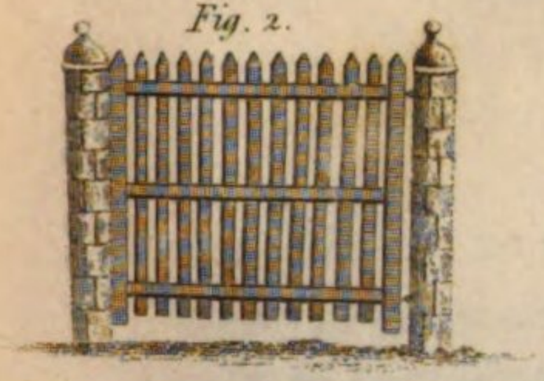


Fig. 7.

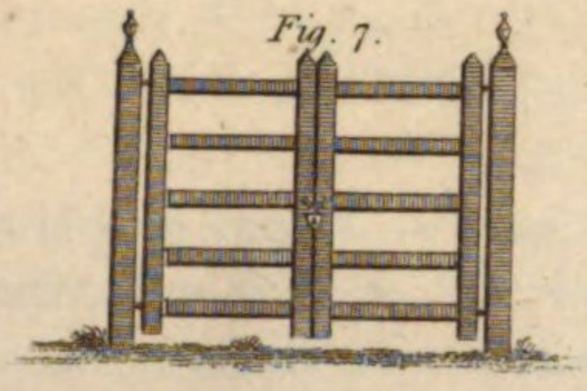


Fig. 8.

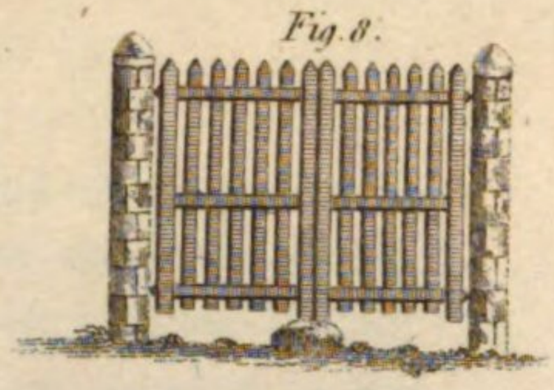


Fig. 3.

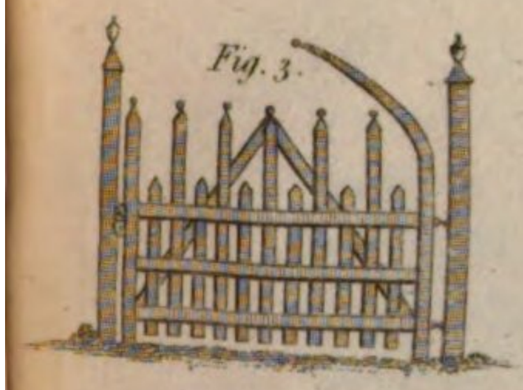
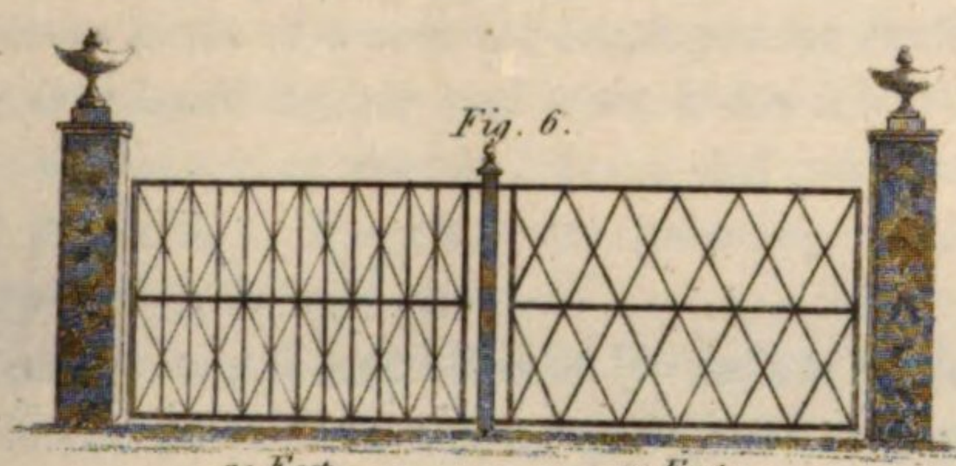


Fig. 6.



10 Feet 10 Feet

Fig. 1.

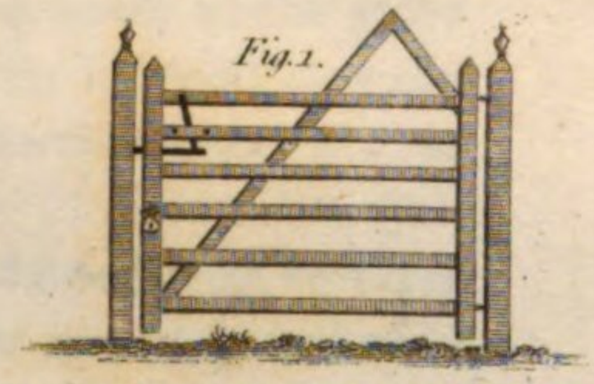


Fig. 15.

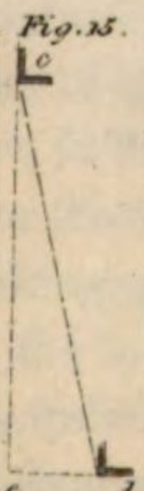


Fig. 4.

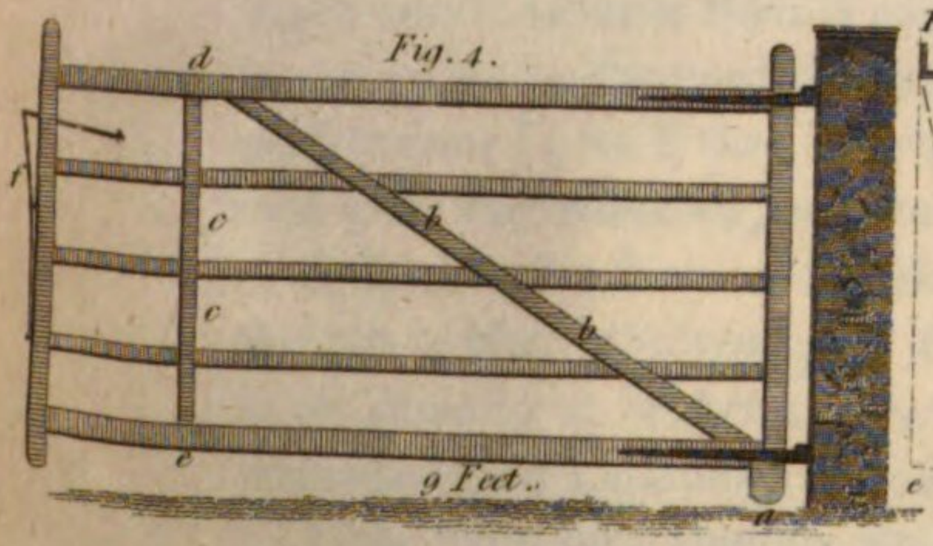


Fig. 5.

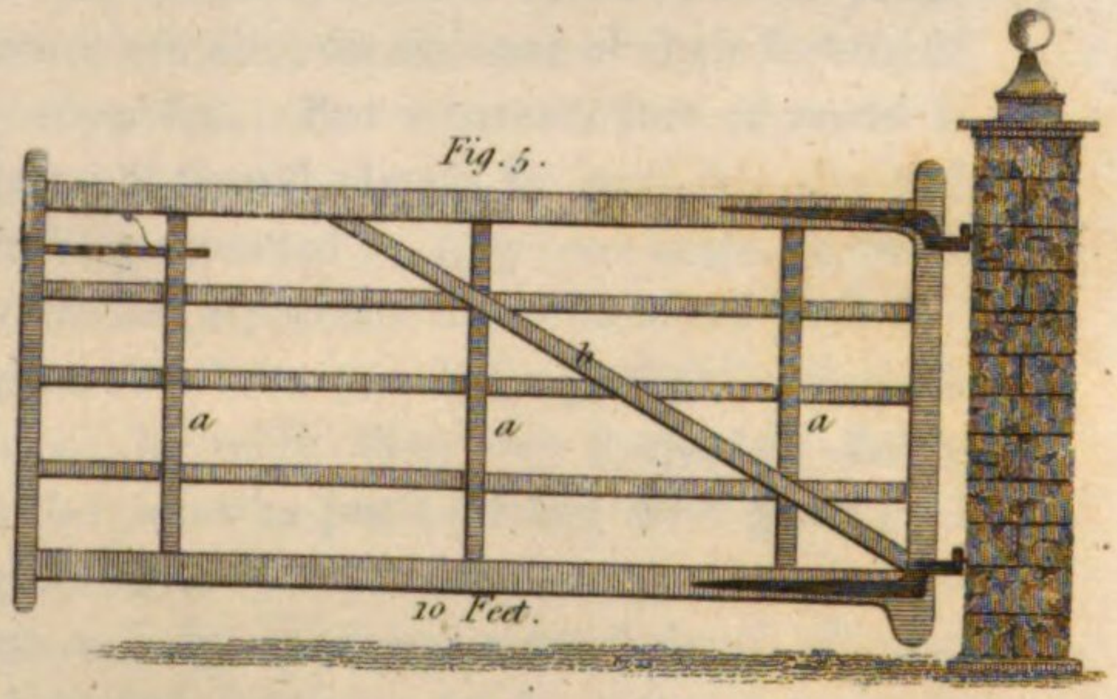


Fig 13.

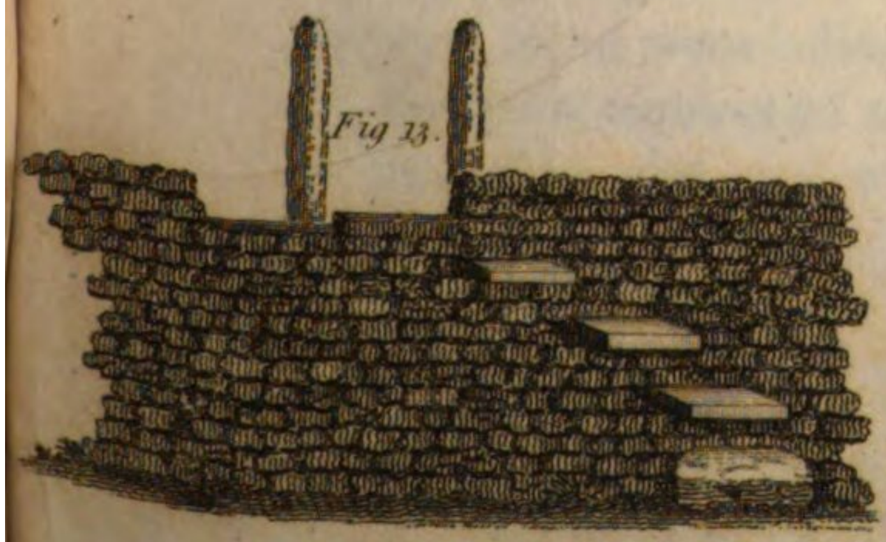


Fig. 14.

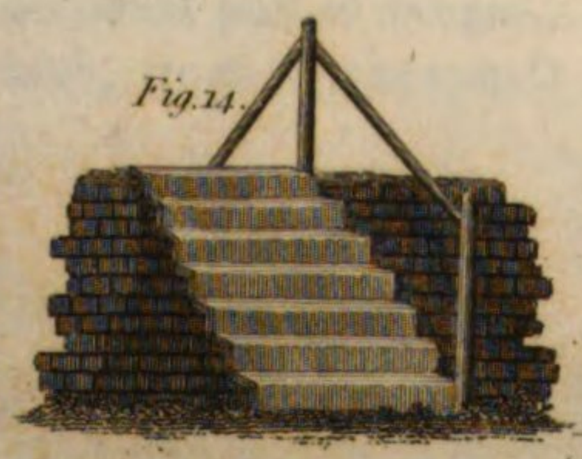
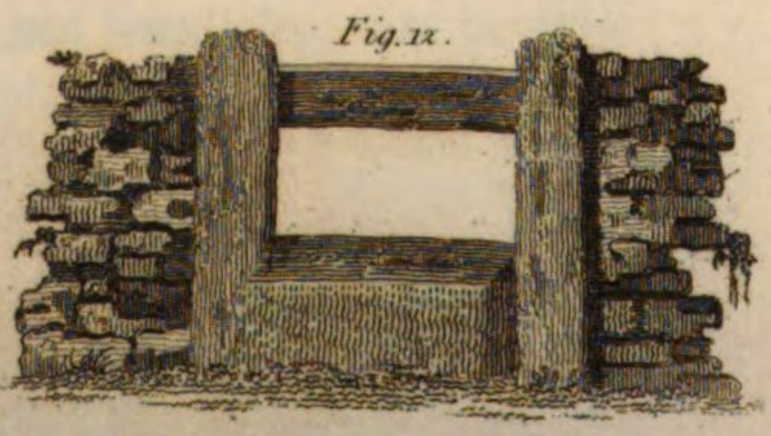


Fig. 12.



and the bitter willow, as by ſuch a plan the farmer reaps advantages in other ways, as well as that of a fence.

Where hedges are made, the ditches, as has been ſhewn, are either ſingle or double; the latter is more ſuitable where much water is to be taken off from the adjoining land; and, in caſes where the earth is well thrown up in the middle, a tolerable temporary fence may be formed.

GATES.

There is much variety in regard to the materials and the manner in which gates are conſtructed, as well as the way in which they are hung; ſome conſiſting of two leaves, others of only one; ſome moving on the centre, and appearing like two gates; others turning on one end; ſome opening to one ſide only, others ſwinging both ways by ſuitable crooks and eyes. Where oak, aſh, or other heavy kinds of wood, are employed for theſe purpoſes, the hanging poſts ought to be placed deeper and more firmly into the ground, as the gates made of theſe woods are extremely heavy, and conſequently liable to drag the hanging poſts forwards. But they are probably more durable than ſuch as are made of the lighter ſorts of wood.

The Dutch willow, and ſeveral other of the lighter kinds of wood, may however be converted to the purpoſe of making gates, with very great advantage to the farmer, as they may often be cultivated on waſte ſpots of the wetter ſorts of ground, and grow ſo rapidly as to be fit for uſe in the courſe of ſix or ſeven years. Gates made from materials of this nature are alſo, on account of their lightneſs, much more durable than is generally ſuppoſed. But whatever ſort of wood is made uſe of in the conſtructing of gates, it ſhould always be perfectly dry and well ſeaſoned; for if that be not ſufficiently attended to, they ſoon begin to crack and give way when expoſed to the weather, eſpecially in the ſummer ſeaſon.

In the conſtruction of the *ſwing-gate*, the bars are ſo long, that too much weight is often thrown upon the hinges, by whic they are frequently liable to be ſtrained or broken; and, unleſs the joints be put together with great correctneſs of workmanſhip, they ſoon give way.

This, therefore, though an expenſive, is by no means a good form of gate. The *double* or *folding gate*, from the bars being only made about half the length, is found to be more laſting, and not liable to the inconveniences of the above. It, however, requires an additional pair of hinges. The *ſlip-bar-gate* isa form of gate often uſed, and which, from its cheapneſs and ſimplicity, may be very

proper and laſting. It merely conſiſts in having poſts fixed up, with mortices cut in them for the bars to be ſlipt into. However, from its being tedious in being opened, and not being capable of being locked or well ſecured, it is probably the moſt ſuited to the inner incloſures of the farm. The *turn-about* or *wirlout gate* is only neceſſary where a frequency of paſſage is required.

A very uſeful form of gate is deſcribed by Mr. Robertſon, in his Survey of the County of Perth. "The backof the gate itſelf," ſays he," (independent of the poſt on which it hangs), has a projection of three inches in the timber on the fore ſide, riſing nine inches from the foot of the moveable part. On this projection reſts the back end of the diagonal bar, which points upwards to the fore part of the gate, and reaches about four feet and a half in that direction. This diagonal bar is of ſuch a thickneſs, that every one of the horizontal bars paſs through it, nicely mortiſed, except the loweſt and the higheſt. About ſix or ten inches from the termination of the diagonal bar above, there is a perpendicular one fixed in the two outſide ones above and below, and of ſuch a thickneſs as to admit all the reſt to paſs through it, mortiſed as they are in the diagonal bar. The reſt of the gate is made in the ordinary way, and may be of any length. Some of them are," he ſays, " made double, having more than one perpendicular bar: but theſe appear to be too complex, and to have too many joints. The excellence of this gate is, that all the horizontal bars, except the higheſt and loweſt, reſt, not on the poſts only, but likewiſe on the diagonal and perpendicular bars; and that the diagonal bar itſelf reſts on the projection of ſolid wood, at the foot of the back poſt: ſo that it is impoſſible the joints can ſtart or the gate come aſunder, until the timber rot; or that the gate itſelf can fall forward, unleſs the pivot, on which it moves, or the pillar on which it hangs, be faulty. It is far ſuperior to any gate whoſe diagonal bar is fixed only by nails to the horizontal ones."

For the uſes of the farmer, thoſe with five bars, properly braced, are probably the beſt. They ſhould be about eight feet and a half or nine feet in width, and from four and a half to five feet in height. The bars ought to be made ſtrong, having the depth of three inches and a half. In many caſes it is of great advantage to have an iron, or ſmall wooden bar, placed between the two lowermoſt bars of the gate, as by that means ſmall animals are prevented from getting through at the bottom. The lighter gates can be made in the fore parts, the better they anſwer, provided they have only ſufficient ſtrength to reſiſt the force that may comeagainſt them. Where horſes are kept,

the top bars of gates ſhould, however, be conſtantly made conſiderably ſtronger than the reſt, as they are extremely liable to be broken by their rubbing their necks upon them.

Gatepoſts, where they can be had, are beſt of ſtone; but where wood is employed for the purpoſe, it ſhould be ſufficiently ſtrong, and ſet a great depth into the ground, being previouſly prepared by tar or oil-paint in that part.

The hanging of gates is likewiſe a point that ought to be attended to, as they are ſoon deſtroyed when they are fixed in ſuch a manner as either to drag upon the ground, or go with too much velocity in ſhutting. The proper inclination or tendency to ſhut of themſelves may be eaſily given them by attending to the following circumſtances. The hanging-poſt being ſet perpendicularly in the ground, a plumb-line muſt be drawn upon it, on which, at a proper diſtance from the top, put a hook ſo that it may project three inches and a half from the face of the poſt; and at a ſuitable diſtance below this, the lower hook muſt be inſerted an inch and a half to one ſide of the perpendicular line, having a projection of two inches from the face of the poſt; the top loop is then to be put two inches from the face of the haw-tree, and the bottom loop three inches and a half from it. Gates when thus hung will be found to have ſufficient fall in every poſition to ſhut without any trouble or inconvenience.

STILES.

Stiles are conſtructed in very different forms, according to the nature of the materials, and the ſituations or purpoſes for which they are intended. Where ſtones are in uſe, a thin flat one is ſometimes ſet on edge at the bottom, to prevent ſmall animals getting through, and a longiſh croſs one placed at top, to prevent their getting over. Where wood is employed, they may have various forms, according to the ingenuity of the workman.

It is well remarked by an intelligent writer on the ſubject of incloſing, that "every gentleman, whoſe eſtate is not already incloſed, will perhaps find his account in beginning with a ſurvey and plan, diſtinguiſhing the different kinds of ſoil, marking the land fit for tillage, and that which is only fit for graſs, and the plantations diſtinct from both. He will thus have the whole under his review at once, and have leiſure to examine, to digeſt, and to amend his plan, both according to his own judgment, and to hear and weigh the remarks of the

beſt improvers in his neighbourhood, who have diſtinguiſhed themſelves by their taſte and their knowledge in rural affairs. This is the time to correct the general plan, rather than to undo any part after it is executed, which always implies weakneſs, precipitancy, and unneceſſary expence. The whole will be divided with propriety and preciſion, ſo as to render it moſt beautiful and moſt convenient; and every part will be deſtined to its proper uſe. If a houſe," ſays he, " is to be ſet down upon it, the whole may be made an ornament to the principal reſidence, by a judicious diſpoſition of the plantations, hedges, and farm-houſes. Even the farms ſhould be divided in ſuch a manner, that the dwelling of each tenant may be as central in his fields, as the ſituation of the ground will admit, to faciliate his carriages and attendance. The very ſteddings of the different farms ought," he thinks, " to claim attention; and much judgment may be diſplayed in their conſtruction and relative ſituation *."

It is further obſerved in the ſame work, that " various methods have been adopted in defraying the expence of erecting incloſures in the firſt inſtance, and of preſerving them in proper repair. In place of giving any detail of theſe, let it," ſays the writer, " ſuffice to mention what appears to be the moſt equitable and effectual. If a farm is to be incloſed and ſubdivided at the commencement of a leaſe, the whole expence of making the fences ought to be laid out by the landlord, who has a permanent intereſt in the ground; and in the groſs ſum of the rent, an equivalent may be charged for the intereſt of the money expended in incloſing. If, on the other hand, a farm is to be incloſed during the currency of a leaſe, the proprietor ought," he thinks, " ſtill to lay out the money, and a contract be made with the tenant to pay ſuch an additional rent in name of intereſt, as may be agreed upon betwixt both parties. In the proviſion made for maintaining the fences in proper repair, the expence ought always to be mutual and equal on both ſides, for very evident reaſons, and theſe repairs executed by ſkilful labourers, when required by either party, and completed to the ſatisfaction of the landlord. Few diſputes," he ſays, " take place about fences, unleſs the agreement be very bungling; the great bone of contention is, the keeping the fences in order; and it is preſumed that by the proviſions pointed out, much contention and many expenſive law-ſuits at the end of leaſes may be avoided."

There can be little doubt but that, by attending to ſuch circumſtances, the

* Robertſon's view of the State of Agriculture, in the County of Perth.

proprietors of land may frequently avoid improper plans and modes of managing the incloſures of their eſtates, as well as prevent the fences, when once formed, from falling into that ſtate of ruin and decay, which is too often the caſe where no ſuitable regulations in theſe reſpects exiſt between landlords and tenants. The general buſineſs of incloſing may likewiſe be rendered more eaſy and convenient, and thus afford encouragement to the beſt, and probably the only means of introducing the moſt improved and advantageous methods of cultivation, and the reception of the greateſt poſſible produce from the land.

SECTION V.

Conſtruction of Roads.

ROADS—Advantages of, various—Circumſtances to be attended to in the Direction of—Different Forms of, conſidered—The Convex—The Concave—The Varieties of flat Forms—No particular Form ſuitable perhaps for all Situations—Various Circumſtances in regard to Forms ſtated—Some Objections to the convex Form, probably not well founded—Concave Form found advantageous in Leiceſterſhire—Peculiarities in the flat Forms, deſcribed—Objects generally aimed at in all—Beatſon's Theory of Roads—Form of the Baſis or Bottom, of much Importance—Application of certain Principles in Conſtruction of—Different Circumſtances to be attended to in—Various Advantages of ſuch Conſtruction deſcribed—Manner of forming the Drains in—When made on this Plan, Roads need not be ſo wide—Much Land may conſequently be ſaved—The Quantity of eſtimated—Different Soils require a Difference in the Conſtruction of Roads—Methods of making them in ſandy—In clayey—In boggy Soils—On the Sides of Hills—Should be kept from having Water running on them in every Conſtruction—Modes of conſtructing iron or railed Roads—Advantages of—Where moſt uſeful—Communication on parochial Roads—Defects of—Means of improving them—Wheels of particular Forms injurious to Roads—Different Effects of the conical and cylindrical—Latter moſt advantageous—Cummings's Eſtimate of the Difference in the Effects of—Forms of Roads that are the leaſt affected by Wheels in general—Fences on the Sides of Roads—Diſadvantages of them—Circumſtances neceſſary to be attended to in.

IT cannot be doubted but that good and convenient roads are of great uſe and advantage, whether conſidered in an agricultural or commercial point of view; yet the beſt means of forming and preſerving them, ſeem, till lately, to have been but very little examined, or attended to. This will be obvious to every one who enquires into the ſubject, as he may frequently find them laid out in the moſt inconvenient and injudicious lines of direction, and conſtructed with conſiderable diſadvantage in reſpect to materials, and the manner of their application. In marking out and directing new lines of roads, the ſurveyor, or the perſon who has the management, ſhould conſtantly keep in his mind a few

leading principles, by which the buſineſs ought always, as much as poſſible, to be regulated; ſuch as thoſe of fixing on the moſt level, the ſhorteſt, and the cheapeſt lines: for though they can, perhaps, be but ſeldom entirely followed, they ſhould be regarded, in every inſtance, as much as is in the power of the perſon who marks them out. Where, however, theſe different advantages can all, or ſeveral of them, be united in the formation of a new road, it will certainly be adviſable to proceed, without heſitation, in ſuch a line; but where that is impoſſible, which, as we have juſt obſerved, muſt frequently be the caſe, that line or direction ſhould be adopted which is the moſt level, for it is obviouſly better to go ſome way about in order to procure a level road, than to go in a ſtraight direction, and have a hilly, uneven one. Small elevations, or aſcents, ſhould not, however, be much regarded, as they may often ſupply materials for the lower hollow parts, by which means the road is not only more conveniently made, but rendered nearly level. It may alſo ſometimes be neceſſary to paſs in the direction of ſlight hills, with the idea of having a ſound, firm bottom, and a road eaſily made; or to avoid ſwamps, moraſſes, and ſheets of ſtagnant water, through which roads are made with great difficulty and much expence. Beſide, there are often other advantages in taking ſuch directions; as it can ſcarcely have eſcaped obſervation, that ſuch roads as are formed on a gentle declivity always wear the beſt, are the cleaneſt, and kept in repair at the leaſt expence. In all flat countries and level ſituations, a ſlight declivity ſhould indeed conſtantly be given to the roads in their firſt formation, which can eaſily be accompliſhed by thoſe who underſtand the nature and proper conſtruction of them*.

Where communications are by ſuch means to be formed with diſtant diſtricts, care ſhould be taken that it paſs through ſuch parts or places as may afford the greateſt and moſt permanent advantages, without regarding in an improper degree the intereſt of individuals.

It is evident, therefore, that as much, in the proper performance of this buſineſs, muſt always depend upon the ſkill and judgment of the ſurveyor, he ſhould, invariably, in finally deciding on a line of road, make himſelf fully acquainted with the nature, circumſtances, and ſituation of the ſurrounding country, and attentively conſider, after repeated examinations, which is, on the whole, the beſt and moſt advantageous direction to be fixed upon.

After having deliberately decided in regard to the line of direction, it will be proper, in the next place, to conſider of the form moſt ſuitable for its conſtruction. On this ſubject very different opinions are maintained. Some contend that roads ſhould be convex; others that they ſhould be concave; others again

* See Beatſon in Communications to the Board of Agriculture, p. 128.

that they ſhould be perfectly flat from one ſide to the other, and in the form of inclined planes longitudinally; and a few, that they ſhould be perfectly flat in every direction. It is probable, however, that no one particular form is calculated to anſwer in, or ſuitable for, every ſituation, but that they ought to be varied according to the particular circumſtances and ſituations of the country through which the road is to paſs. A perſon who has been much engaged in this way aſſures us, that he has been clearly convinced, from very long obſervation and experience, that where roads have been made flat in the middle, with the ſides a little raiſed, ſo as to collect the water to that part, with a proper declivity for it to paſs off longitudinally, they have always worn the leveleſt, and, with proper management, been kept in repair at by much the leaſt expence.

In that part of the country where he reſides, he ſays, a turnpike road was formed upon this principle, about forty years ago, and though in the neighbourhood of a colliery, and, conſequently, many heavy carriages paſſing over it at all times of the year, he believes it will not be too much to ſay that it is the beſt turnpike road in the county, and repaired at the leaſt expence of any, upon which an equal number of heavy carriages paſs.

The convex or rounded form of roads is, notwithſtanding, in general, perhaps, by much the beſt, and certainly the moſt common, but the degrees of convexity are very uncertain and indeterminate, depending for the moſt part on the caprice of the perſon employed in the making of them. In general, however, they are conſiderably too much rounded, ſo as in ſome inſtances to be very inconvenient, and even dangerous to the traveller. The adoption of this rounded mode of making roads, ſeems to have proceeded on the ſuppoſition that water would be more readily conveyed off into the ditches or drains on the ſides. But this is not exactly the fact, for much of the water is obviouſly detained on the ſurfaces of ſuch roads by the tracks, irregularities, and roughneſſes, produced by the impreſſions of the wheels of carts and other ſimilar cauſes, which by thus ſtagnating, and being agitated and wrought up by the frequent paſſing of carriages, and other heavy machines, ſoon renders the roads uneven, full of depreſſions, and almoſt impaſſable. The convex method of conſtructing roads does not, therefore, effectually prevent water from reſting upon their ſurfaces. But, beſides this, there are other diſadvantages attending this form of roads; the unequal preſſure which the wheels of carriages muſt have in ſuch caſes, not only tends very much to break up and deſtroy the roads, but, at the ſame time, renders travelling on them very inconvenient and unpleaſant, eſpecially where the convexity is great.

With the mode of forming and conſtructing theſe kinds of roads in the firſt in-

ſtance, a late writer alſo finds great fault, conceiving it highly diſadvantageous and abſurd. The improprieties complained of in the methods of preparing ſuch roads for the reception of the hard and more ſolid parts of the materials, are repreſented in the ſection of a road ſo formed, which may be ſeen in the annexed plate. When thus prepared and made up, it is ſuppoſed, that though it may be imagined that the whole of the water that falls on the road may be conveyed away by the ditches or drains on the ſides, yet if it be examined in a wet ſeaſon it will, it is aſſerted, be found that, in general, however great the convexity may be, the water will ſtand, as has been obſerved above, in the various ruts and depreſſions that may have been made on it, particularly where the road has been ſo long made uſe of, as to have worn down and reduced the ſtony materials on the ſurface, and forced up the moiſt earthy ſubſtance through them; and that if the road has been recently made or repaired, and the materials are of ſo porous a nature as to let the water paſs through them, it will then lodge in the hollows on the convex retentive ſtratum below the hard materials, eſpecially at the ſides, when obſtructed by the footways, by which the bed or foundation of the road is kept conſtantly wet, and thereby quickly becomes out of order. By this conſtant ſtagnation of water below, too, the hard materials ſink down into the ſoft earthy bed below, which works up through them, and cauſes all the dirtineſs obſervable on the ſurface of them in bad weather, notwithſtanding the thickneſs of the covering of hard materials may, at firſt, have been ten or twelve inches. Even where under-drains are formed for taking off the water below the footways, at very ſhort diſtances, this is not, it is thought, prevented, as the intermediate ſpaces quickly become ſo impervious, that the moiſture does not paſs through them to ſuch drains; but the wet earth below is converted into a kind of *puddle*, ſimilar to that made uſe of in preventing the entrance of water in different ground works, by which it is forced up, and ſtands in the depreſſions on the ſurface. But there is, it is ſaid, another method of forming this kind of roads which has been lately deſcribed * and recommended, in which it is propoſed to leave a hollow, or vacuum as it is termed, in the middle, in which the ſolid materials are to be placed, and which is ſhewn in the annexed plate. The ſole difference between this, and that which has been mentioned above, ſeems, it is ſaid, to be, that inſtead of the bottom of the hollow being made convex, it is formed more flat and deeper. It is therefore ſuppoſed that it is liable to the

* Agricultural Survey of the County of Bedford.

ſame objections that have been made to the firſt in a ſtronger degree; and beſides that it requires a greater thickneſs of hard expenſive materials, which muſt be of the greateſt depth in the middle, or part where the ſlighteſt impreſſions are made, and the leaſt injury done by the wheels of carriages or other cauſes *.

The objections, eſpecially to the firſt form, when fully conſidered, will not, however, probably be found to be either ſo forcible or ſo generally applicable as the author ſeems to ſuppoſe them; as it is eaſy to perceive that the convex or rounded baſis on which the hard materials reſt, may, in a great number of caſes, be highly porous, and capable of admitting the water that may come upon it from the ſurface of the road, through the ſtony or gravelly materials, to percolate and paſs through it to the drains which are prepared for taking it away, or even, in ſome inſtances, it may ſink quite down into the looſe porous bed itſelf, and in this way keep the road perfectly dry. It is, therefore, only where the baſis or foundation of the road, on which the hard materials are to be depoſited, whether it be of a convex or hollow form, is compoſed of a retentive or impervious material, ſuch as clay, that ſuch objections can have any weight; and even in ſuch caſes, the ingenuity of expert road-makers frequently prevents the injurious effects that are apprehended from taking place, by providing a *ſubſtratum* of ſome ſort of porous or penetrable materials, for placing the ſtone, gravel, or other hard ſubſtances, upon, that may be employed in forming the upper part of the road. If the looſe penetrable ſubſtances made uſe of in this way be laid of a ſufficient thickneſs, and in a proper form in reſpect to the drains, there can be little doubt but that roads, even when formed in a retentive ſoil, may be kept perfectly dry, and free from the ſtagnation of moiſture below them. Looſe ſand, the ſcrapings of old roads, and many other ſubſtances that can, in many ſituations, be procured in large quantities and with great facility, may be uſed with ſucceſs for the purpoſe.

Concave roads are formed in an exactly oppoſite manner to thoſe of the rounded or convex kind, having the greateſt depreſſion and flatneſs in the middle, where they are the higheſt and moſt round. The ſides of theſe roads are generally made with a ſmall inclination, while the middle part is formed either quite flat, or with a very ſlight degree of concavity, and a ſmall deſcent forwards is given them where neceſſary, in order to carry off the water to outlets conſtructed for the purpoſe. This ſort of fall is formed at a trifling expence by raiſing ſome parts,

* Beatſon in Communications to the Board of Agriculture, vol. I. p. 132.

and lowering others. A ſpirit-level ſhould be employed in the buſineſs when neceſſary, and where the fall is gentle, the inclined plane can ſcarcely be too long*.

In moſt ſituations too, to make theſe roads ſound, a good ditch muſt be made on each ſide, a foot or more deeper than the middle of them; and it adds to their ſafety if theſe ditches be made on the field ſide of the roads; or, where they are ſufficiently wide, firm earthy ribs, three feet in height, may be left on the ſides of the ditches. The leading conſideration in conſtructing roads in this way, is that wherever water flows upon a road, that part of it, if the bottom be ſound, is, it is ſaid, for the moſt part, found the firmeſt, and leaſt deſtroyed. But roads, made on this plan, ought at firſt to be well ſet out and formed, and have the materials laid on true. All ſprings and dribblings of water ſhould, likewiſe, be effectually cut off and prevented from running on them; for if theſe circumſtances be not cloſely attended to, they ſeldom anſwer well.

The advantages attending this form of road are ſtated to be theſe, that there are three parts on which carriages may be driven, without having any improper inclination, or undue preſſure on any of their wheels, by which means the draught is more eaſy to the horſes, while the roads are more equally worn, and, in conſequence of that, much leſs injury done to them.

Beſides, they do not tear ſo much it is ſuppoſed by heavy rains, and are kept in repair with much greater eaſe. In ſome inſtances, too, the waſhings of ſuch roads may, it is conceived, be uſefully turned upon graſs lands.

However much this form of road may vary from thoſe which are in general uſe, it has been contended for by ſome very intelligent advocates, as the late Mr. Bakewell, and Mr. Wilkes; and different roads in Leiceſterſhire have been formed on the plan, it is aſſerted with great advantage, both in reſpect to the roads themſelves, and the cheapneſs of their being kept in repair†.

Thoſe who are in favour of *flat roads with longitudinal ſlopes*, in the manner of

* See Communications to the Board of Agriculture, vol. I

† The directions of Mr. Wilkes, as ſtated in an ingenious paper, in the firſt volume of Communications to the Board of Agriculture is, that—

When the fall is one foot in 150 or 200 feet forward, the fall from the ſides towards the middle ought to be 15 inches in 20 feet.

When One foot in 100 to 150, to be 12 inches.
One foot in 40 to 100, to be 10 inches.
One foot in 30 or leſs, to be even the whole breadth.

Where the width of a road is 60 feet:
One foot of fall to each 40 feet in length of the road:
Twenty feet from the ſides towards the middle, to have 9 inches of fall.
The inner 20 feet to be flat.

very acute inclined planes, contend that by being flat and level from ſide to ſide, the effect or preſſure of wheel-carriages muſt be more equally exerted, and the friction leſs; while every part of the road may be made uſe of with equal facility and eaſe, that of courſe the wear will be more equal, and the road be eaſier kept in order, and with a ſmaller quantity of materials. To ſome it may appear, and probably is, a difficult point, to keep ſuch roads ſufficiently dry; it has, however, been already noticed that the impreſſions cauſed by the wheels of carriages detain the water on the rounded or convex roads, and prevent it from paſſing off at the ſides; it may follow, then, that as this form of road is intended to have in the level parts very gentle ſlopes, ſuch as the fall of one foot in fifty, for the conveying off of the water, theſe ruts or depreſſions may ſerve as conductors, and thereby promote the paſſing off of the water into the lower parts of the ſlopes, whence it is conveyed away by the ſide drains. On this ground, it is ſuppoſed that this form of road may be kept clean and dry with greater eaſe than thoſe of the rounded or convex kind.

The laſt form of road to be noticed is that which is *quite flat in every direction.*—This is ſupported on nearly the ſame grounds as the above, only it is contended, that as there are few ſituations ſo very level for any length that water will not run one way or the other, it is quite uſeleſs and unneceſſary to be at the trouble of forming ſlopes or inclined planes, but that ſuitable outlets ſhould conſtantly be provided at every hollow part for taking off and conveying away the water; that ſhould the road in any part be perfectly level, ſhallow croſs drains, which it is ſuppoſed will occaſion no interruption to carriages, ſhould be formed at every fifty or ſixty yards, or nearer, if requiſite, by which the road may be kept ſufficiently dry and in order.

From theſe accounts and details of the different forms of making roads, it is evident that there are two principal objects to be aimed at in the buſineſs: 1ſt. That of conſtructing them ſo as to render them as free of moiſture as poſſible at all ſeaſons; 2d. That, that kind of conſtruction be given them which is moſt calculated to leſſen the draught at the eaſieſt expence. Theſe probably embrace all the neceſſaries for forming perfect roads, but the difficulty depends on obtaining them in the completeſt manner; ſeveral modes of doing which have been juſt deſcribed, and may be had recourſe to according to the particular circumſtances of the different caſes.

The author of a valuable communication on the ſubject of roads*, has propoſed a new theory of conſtructing them, which, he ſays, is founded on nature. It is well known that ſome of the *ſtrata* that are found in the bowels of the earth

* See Beatſon in Communications to the Board of Agriculture, vol. I.

are of ſo cloſe and denſe a texture, as not to admit moiſture to penetrate them, while others are ſo open and porous that they readily permit water to paſs through them in every direction, until it meets with ſome obſtruction, or finds a channel to convey it off. Among theſe different *ſtrata* there is alſo much difference in reſpect to their denſity and poroſity; and in proportion as they partake more or leſs of theſe qualities, they admit moiſture to tranſude through them with greater or leſs facility. In further illuſtration of his ideas, and in applying theſe principles in the conſtruction of roads, it is obſerved, that, ſuppoſing the ſection of a hill or eminence compoſed of a number of *ſtrata;* if the uppermoſt *ſtratum* or ſurface ſoil be of a porous nature, it is obvious that, any water falling upon it muſt paſs through to the next *ſtratum* underneath, where if it cannot penetrate any further, it muſt glide along the ſurface till it finds an outlet or vent at the bottom of the eminence. If, however, the ſecond ſtratum ſhould be hollow for ſome diſtance, the water will lodge in that hollow, and conſtitute a kind of pool or bog, as is often noticed on the tops of hills; but if in this hollow place there be a communication with the third ſtratum, which is porous, no water will ſtagnate there, but will paſs through and run along the fourth *ſtratum*, which is denſe, until it iſſues at the ſide or bottom of the hill. It is further evident, that if the firſt or uppermoſt *ſtratum* ſhould be of a denſe texture, as clay, any water coming upon it will not only ſtagnate in the large hollows, but in all the ſmaller ones, as well as in the other irregularities and depreſſions that may be on its ſurface. It is therefore clear, it is conceived, that in order to keep the ſurface of ſuch a piece of ground as that deſcribed dry, it is not of much conſequence what ſhape or form the ſurface has, whether it be convex or flat, ſo that there be a communication with an under *ſtratum* ſufficiently porous to carry away the water below: it is, however, of much conſequence that the form of the upper ſurface of that *ſtratum* on which the water is to glide, ſhould be ſmooth and even, in order that it may the more readily paſs off. This will probably be better underſtood by conſulting the ſection to which it relates, in the annexed plate.

The application of this reaſoning, in the formation of roads, is as follows: "Where a new road is to be formed, let it," ſays the author, "be done in the firſt inſtance nearly in the uſual manner, with ſuch materials as are on the ſpot, and the nearer the quality of theſe approaches to clay, ſo much the better. Inſtead, however, of forming it convex, as is generally done, it ſhould be quite ſtraight on each ſide, and meet in an angle or ridge in the middle of the road, having a ſlope from thence to each ſide of about an inch in a foot; and ſmall drains at theſe parts, for the more eaſily conducting away the water that may be collected

at thoſe places. The road being thus formed muſt," he ſays, "be allowed to harden and ſettle for ſome time, before any other materials are laid on; great care muſt be taken, while in that ſtate, to let no carriages or cattle upon it, and it ſhould be rolled with a long wooden roller that will reach at once nearly over one ſide of the road. This roller ſhould be loaded with a box of ſtones to make it ſufficiently heavy, and that it may be the more portable when that box is taken off; and it may be ſo contrived that, by changing the horſes from one ſide to the other, there will be no occaſion to turn the roller, in order to make it roll the ſame ſpace over again. Being rolled in this manner, will conſolidate the materials compoſing the ridge, and prepare it for receiving thoſe to come afterwards; for it is a moſt abſurd practice to lay hard materials in the common way, upon the firſt form or baſis of a road, before it is ſufficiently firm to bear them.

" Being thus formed and properly ſettled, the next ſtep to be taken is," he thinks, " to imitate the works of nature in dry ſoils as nearly as poſſible, by forming a *ſtratum* penetrable by water, compoſed either of ſand or ſandy gravel, or any other ſubſtance eaſieſt to be got, that is ſufficiently porous to admit water to paſs through it. This *ſtratum* ſhould be laid quite level, and extending from one ſide of the road to the other, filling up alſo the ſmall drains on the ſides (as may be readily ſeen by referring to the annexed plate). Over this are to be laid the beſt materials that can be got for completing the road, conſiſting either of ſtones broken very ſmall, or of the beſt gravel. This coat of hard materials need not," he ſuppoſes, " exceed above ſix or ſeven inches in thickneſs, which being much leſs than is commonly uſed, will be a conſiderable ſaving: and it may even ſtill be leſs," he thinks, " if the directions hereafter given are ſtrictly attended to. If this covering conſiſt of broken ſtones, they ſhould afterwards be laid over with ſand or fine gravel, when eaſily procured, ſo as to fill up all the cavities betwixt them. The ſand or rubbiſh from a free-ſtone quarry is excellent for this purpoſe, provided there is no mixture of earth in it, which ſhould be carefully guarded againſt in every ſtep taken after the road is firſt formed. Theſe finiſhing materials being properly laid on and ſmoothed with a rake, the whole ſhould now," he ſays," before any carriages or horſes are admitted upon it, be well rolled with a heavy iron roller, divided in three parts," as repreſented in the plate on rollers. The writer alſo ſuggeſts " that it would ſave much expence in repairing roads, eſpecially new ones, if rollers of this kind were more generally employed, as it cannot be ſuppoſed that they will immediately bear wheel carriages, or remain long in repair, when compoſed entirely of looſe materials, unleſs ſome pains be taken to conſolidate them. Rolling would of courſe, it is ſuppoſed, produce the moſt advantageous and uſeful effects, and

tend very greatly to keep the roads in an even ſtate, and free from deep ruts and hollows; and that nothing could conduce more fully or more effectually to produce and preſerve firmneſs, without which it is utterly impoſſible to have good roads."

The advantages of having a road laid out and conſtructed in this way are ſaid by the author to be theſe: "that by having a level ſurface, every part is convenient and ſuitable for carriages, and will, of courſe, be equally made uſe of; from which the deep ruts, ſo common in other roads, will, in a great meaſure, be prevented. It will, on this account alſo, be much eaſier kept in repair; and if well managed at firſt, will be conſtructed at leſs expence than by the common modes of making roads, eſpecially in ſandy ſoils, or where ſand or gravel can be procured with facility. On ſuch a road the draught too will be conſiderably eaſier. It is likewiſe a great advantage in theſe roads, that by having an under *ſtratum* through which water can penetrate, and the ſpaces among the harder materials being filled with the ſame kind of porous material, no water can ever ſtagnate on the ſurface, nor can it ever in wet ſeaſons become ſo dirty as other roads; all the water that falls, except, perhaps, in very heavy rains, being conducted away underneath, as well as in every part." In concluding that, from the interſtices between the different parts of the hard materials being filled up with looſe porous ſubſtances, through which moiſture can readily paſs, roads never become ſo dirty or water ſtagnates ſo much upon them, the author is probably miſtaken; as a very ſhort examination of the matter will clearly ſhew, that whether the covering of roads be of ſand, ſmall ſtones, or gravel, when they become pulveriſed by the wheels of carriages, which they ſoon will be in dry weather, and on wet weather coming on will be waſhed into the various interſtices of the ſtones, or other hard materials, effectually blocking them up, and thus rendering the ſurface completely *puddled*, to uſe a term employed in ground works, and thereby to retain water equally with any clay.

Sometimes it will be requiſite, it is ſuppoſed, to have croſs drains carried under the fences from the ſmall ſide drains mentioned above, at the diſtance of every ten or fifteen yards, where the level of the ground will admit of them.

Theſe may be made of any ſuitable material; if of wood, it is conceived that an inch in the bore will be ſufficient. Such a narrow paſſage muſt, however, be very liable to be choked up and obſtructed; it would, therefore, be much better to have them two or three inches, or of ſuch ſizes as may be ſuited to the quantity of water that may at any time come upon them.

It is to be particularly noticed, that on all ſloping roads on a declivity, where the water is apt in heavy rains to run upon the ſurface or at the ſides, that it ought

never to be ſuffered to paſs in the ſame direction more than ten or fifteen yards, but at ſuch diſtances to be conducted away to the main drains, at the ſides. By this means it will do little harm, as it can never increaſe to more than a weak ſtream; but if it be permitted to run one or two hundred yards, it will probably be ſwelled to ſuch a ſize before it paſſes off, as to waſh away much of the materials, and do conſiderable damage to the road or fences on the ſides of it *.

When made on this conſtruction, the ingenious author ſuppoſes, that roads need not be quite ſo wide as they are in common, as the whole ſurface of them from ſide to ſide will be in uſe. From twenty to twenty-four feet wide, he thinks, will be ſufficient; except it be in the vicinity of large and populous towns, or near extenſive works where a great number of carts or other carriages are employed, in which ſituations they may with propriety be made much wider, as from thirty to forty, or even fifty feet. In the interior parts of the country, twenty feet in width will, indeed, anſwer every purpoſe. It has been obſerved in many places where the roads have not been more than eighteen or twenty feet wide, and properly made from ſide to ſide, that they were in much better condition than the neighbouring ones, which were from thirty to forty, or fifty feet in width. On theſe wide roads, formed in the common way, there is, it is obſerved, ſeldom more than eight or ten feet in the middle of them generally made; the remainder on each ſide being taken up with heaps of ſtones, ſcrapings, and rubbiſh of other kinds, which, though they may be ſometimes wanted in repairing the roads, ſhould not be ſuffered to remain in ſuch ſituations, as they may be dangerous for horſes and carriages in the dark. Beſides much valuable land is, he thinks, loſt to the community †, and conſiderable injury frequently done to the farmer, by the ſeeds of noxious weeds which are ſuffered to ripen and be diſſeminated from ſuch ſituations.

The difference of ſoils makes conſiderable difference in the conſtruction of roads. Where the ſoil is of the ſandy kind, roads may be made with great facility on the plan juſt deſcribed, as there will be little more to do than level the ſurface properly, fill up the different hollow places, roll it very well with the long

* Beatſon in Communications to the Board of Agriculture, vol. I.

† The mode of calculation by which he attempts to ſhew the quantity of land thus loſt is this: "Suppoſe," ſays he, "the medium neceſſary width of roads to be ſeven yards, or twenty-one feet, and that the medium width now made is eleven yards, or thirty-three feet; this is, upon that ſupoſition, four yards wider than is neceſſary, which in every mile is a loſs of one acre one rood and two perches; and ſuppoſing there are 5,000 miles of ſuch roads in the whole kingdom, there is a loſs of more than 6,300 acres, which, if eſtimated the ſame as the improved value of the waſte lands, at 27*s.* per acre, and at thirty years' purchaſe, would produce 255,150*l.*: a ſum which, if laid out in improving the roads and making eaſy communications through different parts of the kingdom, would," he thinks, "be of the greateſt public advantage.

wooden roller, and lay on ſuch materials as are intended to finiſh it with, in the manner that has been already deſcribed, and afterwards roll it very well with the heavy iron roller. But if the ſoil conſiſt ſolely of a deep looſe ſand, the beſt and eaſieſt method of making a laſting road, is to conſtruct it to the intended width for the hard materials, at the ſides of which channels ſhould be dug eighteen or twenty inches in depth, and about the ſame width; theſe muſt be filled and firmly built up with ſtrong turf or clay, or any other ſolid ſubſtance that will prevent the materials to be laid on the road from ſpreading to either ſide, openings being left at every ten or fifteen yards to let the water falling on the middle part of the road paſs through more readily. But where the nature of the ground is ſuch as to require to be made up, a ſmall wall of the ſame materials muſt be built on each ſide, inſtead of the channels, nearly of the ſame height as the ſurface of the road is to be. By this means the hard materials which are laid on will be prevented from ſpreading, which is the chief reaſon of roads in ſuch ſoils ſo ſuddenly giving way; and theſe materials will not be ſo apt to ſink down into the ſand, eſpecially if it have been well rolled before their application, and at times after it has been finally completed *.

If materials can be readily procured to cover the road from ſide to ſide, and it have a fence at each ſide, the walls will not, it is remarked, be ſo neceſſary, as they are principally intended to keep the ſolid materials together, where they are not to be applied the whole breadth of the road. Should theſe ſmall walls, however, be found neceſſary, the ſpaces at the ſides, by being coated with gravel or free-ſtone ſand, will make good foot-paths.

In clayey ſoils the roads are, it is obſerved, for the moſt part extremely bad and diſagreeable; and principally for this reaſon, that proper ſteps are not taken to guard againſt water ſtagnating on their ſurfaces. This may, indeed, occaſionally ariſe from the want of materials, ſuch as ſand and gravel, though it is far from being commonly the caſe. It is remarked, in the valuable paper juſt quoted, that "it ſeems hardly ever to have occurred to thoſe who have had the direction of ſuch roads, that *ſand*, properly applied, would, in a great meaſure, remedy all the defects complained of;" and there are very few diſtricts of a country, it is added, in which ſome ſort of ſand, free-ſtone, rock or ſandy gravel, may not be obtained, by proper exertions, though in ſome ſituations it may be procured with greater expence and difficulty than in others. But where no hard materials at all can be had, if the roads were formed in a ſimilar way to thoſe we have deſcribed above, the inconveniences attending them would moſt probably be readily removed. The clayey foundation ſhould be pared

* See Beatſon in Communications to the Board of Agriculture, vol. I.

away in ſuch a manner as to form a ridge in the middle of the baſis or bottom part; and ſlight openings or drains be made at every ten or fifteen yards, or at ſuch places as are hollow, in order to conduct off the moiſture into the principal drains. The foundation, thus prepared, being then filled up with ſand, or ſome other porous ſubſtance eaſily procured, and finiſhed in the way that has been already mentioned, a good road may be formed. The manner of effecting this buſineſs may probably, however, be better underſtood by conſulting the plate.

In making roads through bogs or moraſſes, the firſt thing to be done is to drain or draw off as much of the ſtagnant water as poſſible, which may often be beſt accompliſhed by cutting ditches or drains of ſufficient depth on the inſide of the fences, where they are incloſed, or deſigned to be incloſed, on the ſides. For this purpoſe, ſuch drains ſhould, however, be formed a conſiderable time before any thing further is attempted. Twelve or ſixteen months, according to the ſtate and circumſtances of the caſes, are probably little enough, as the ground, if very boggy, will ſettle very much after the water is taken off, and in ſome parts probably more than others, as the ſoil is more or leſs moſſy or retentive of water. Theſe will, therefore, be better diſcovered by ſuch a delay, in order to their being filled up and levelled, which is readieſt done by the materials cut from off the elevations, or ſuch other ſubſtances as are near at hand. But in whatever way this is done, the ſurface ſods ſhould be carefully pared off, both from the elevations and hollows, by a ſuitable inſtrument, ſuch as a paring ſpade, and laid aſide until the hollows and depreſſions are filled up and quite levelled; they ſhould then be laid on again, by which means the whole ſurface will be rendered not only level, but of an equal degree of toughneſs, which is a point of conſiderable importance.

After theſe preparatory ſteps have been taken, the breadth of the part deſigned for the reception of the hard materials is to be marked out, and covered with ſand, or ſuch other porous ſubſtances as have been mentioned, to the thickneſs of ten or twelve inches at leaſt. This ſhould then be well rolled, and finiſhed in the way that has been already deſcribed. If this plan be ſtrictly adhered to, there can be little doubt of making good roads, even on moſſy or boggy ſoils *.

Other methods of making roads through theſe ſoils are, however, ſometimes practiſed, as by laying a foundation of broom, furze, heath, willow, or other materials of the ſame kind, and then placing the hard materials upon them; but ſand or ſome other porous hard material is always to be preferred, where it can be readily obtained, and where the line of the road is rendered properly dry before the materials are laid on; as woody ſubſtances ſoon begin to decay, and conſe-

* See Beatſon in Communications to the Board of Agriculture, vol. I.

quently let down ſuch materials as are placed upon them, and thus quickly render the whole of the buſineſs to be performed over again.

In conſtructing roads in all kinds of ſoil, the ſame rules and directions that have been given above muſt be attended to, only varying them according to the nature of the materials that are to be employed, and ſuch local circumſtances as may have any influence.

When roads are to be cut or formed on the declivities of hills, there are a few circumſtances to be attended to, in addition to thoſe which have been ſpoken of, in conſtructing roads where the ground is nearly on a plain or level from ſide to ſide. It not unfrequently happens in theſe caſes, that the part to be hollowed out and removed affords a ſufficient body of materials for making the road, and the parts from whence they are removed ſeldom require any covering to be placed upon them. This, however, muſt be regulated by the nature of the ſoil, and ſolidity of the bottom which is thus left. Where the whole breadth of the road is made from the ſolid, and that has a ſufficient degree of hardneſs, no extraneous materials whatever will be requiſite, but in caſes where the ſoil is a compound of clay and gravel, or where it is of a very ſoft earthy nature, an application of the principles and directions which have been already advanced will be neceſſary in forming it.

Where the lower part of the road is to be made up from that which is to be removed from the upper, it ſhould be conſtructed conſiderably higher at firſt than the proper level, or bottom of that part from which the materials are taken, in order to allow for the ſettling, which may be much haſtened by rolling; but the hard materials ſhould on no account be laid on before this has been well accompliſhed.

Where the eminence is of much height above the road, the fall of water is ſometimes conſiderable. In general, it is the beſt method, in theſe caſes, to ſtop the water at a ſhort diſtance from the road ſide, and thereby prevent it from running down the face of the bank; for if it be permitted to trickle down in this manner, it will quickly, by means of froſts and other cauſes, deſtroy the bank, and choak up the drains, whether they be open or covered ones; if covered, the earth, which is conſtantly mouldering down from ſuch cauſes, will ſoon become ſo cloſe and compact, that the water cannot paſs through it to the drain, before it runs off upon the road; and if open, they are kept clear with great trouble and difficulty. But by ſtopping the water about five or ſix feet from the bank, and drawing it away to a proper outlet, the road may be kept dry with greater certainty and eaſe. Should the face of the bank have any irregularities, the water, in ſuch caſes, may be taken away, by having the drain to recede from

the bank in ſuch places, and keeping the courſe conſtantly on a due level; or the ſame purpoſe might be obtained by letting it be taken off in the hollows, by means of ſmall receſſes faced up with ſtone, or by ſpouts made of wood and ſet upright in the bank at theſe hollow places, and communicating with covered croſs drains under the road *.

In laying out and conſtructing theſe, as well as all other kinds of roads, it is likewiſe obſerved, that care ſhould conſtantly be taken that no water runs upon them, except what falls in rain. But in caſes where this cannot be eaſily prevented, and where a ſtream of water muſt of neceſſity run on the ſide of a road, the drains or ditches, which as has already been obſerved are the beſt on the inſide of the fences, muſt be made of ſuch dimenſions as are ſufficient to take the water that may come into them at different ſeaſons. Thoſe ſmall drains, filled with ſand or gravel, which have been ſpoken of above, are only ſuitable for ſuch roads as cannot have any ſuperabundant quantity of water at any time coming upon them.

That roads may be conſtructed in the ridge or ſloping form that has been deſcribed above with much propriety and ſucceſs, in various ſituations, there cannot be much doubt; though experience, which is probably the beſt guide, would ſeem to ſhew, that the ſlightly convex ſhape is not only more generally applicable, but that which admits of the materials being laid in the moſt advantageous manner, in reſpect to the preſſure and wear of heavy carriages, as well as other points of importance. But whichever form may be adopted, the road ſhould never have much elevation in the middle, or be greatly rounded, only ſo much that the water may be well and eaſily taken off †; as where either the one or the other is the caſe, there muſt be great inequality produced in the preſſure of carriages, by the weight being ſo much thrown on the lower wheel, and an increaſe of friction, from the inſide of that part of the wheel through which the axle-tree paſſes bearing too hard againſt the ſoulder, and the outſide too much on the pin which confines it in its ſituation; by which the difficulty of the draught is greatly augmented and rendered more inconvenient for the animal. And further, accidents are more liable to take place in conveying top loads, or ſuch ſubſtances as are of a liquid nature ‡.

There is another method of conſtructing roads, which may be applicable in certain circumſtances, and particular ſituations. This is that of forming them of rails of wood or iron, of different ſizes, according to the ſituation and weights

* See Beatſon in Communications to the Board of Agriculture, vol. I.

† Donaldſon's Modern Agriculture, vol. IV. p. 78.

‡ Holt's Hints in Communications to the Board of Agriculture, vol. I.

that are to be carried, with grooves in them for the wheels to run in*. Theſe are laid on a perfect level, and *inclined planes* formed where neceſſary, the ground being firſt formed true, and rendered dry by drains. By which, and the uſe of proper machinery, heavy carriages may be forced up or let down as the nature of the caſe may require. As roads of this kind are very liable to wear out where wood is employed, it is probably the moſt adviſable, in moſt caſes, to have them made of caſt-iron; and they ſhould always be double, one being placed at a ſmall diſtance from the other, having communications, at ſuch diſtances as may be convenient for the purpoſe of paſſing in either direction: where iron is uſed, it is by much the beſt way to have the rails ſecured in ſtone-work, as when prepared in this way, it would be very little liable to be out of order. The carriages, of whatever kind, which are to travel on ſuch roads, muſt be adapted to the purpoſe; the beſt general mode of conſtructing which, where heavy loads are to be carried, would probably be that of their having low iron wheels. The principal advantages of roads of this nature are, that great weights may be conveyed on them at little expence of team, while they do not coſt much more in forming than well-made turnpike roads. Extenſive roads on this plan are met with in different places, as near Colnbrook-dale in Shropſhire, and at Orrel near Wigan, Lancaſhire, for the purpoſe of conveying coals, &c. It is probably in ſituations and for uſes of this kind that ſuch roads can be had recourſe to with the moſt advantage, as by means of them the cutting up and deſtruction of other roads may be much leſſened or wholly prevented.

Repairing Roads.—However common the practice may be for the ſurveyors, or overlookers of roads, to permit them to be much cut and broken up before any effectual means are employed in repairing them, it is certainly extremely injudicious and expenſive; as experience has fully ſhewn, that it is much the moſt economical plan to never allow them to get out of repair to any conſiderable degree. Where circumſtances will admit of it, the beſt, and probably the moſt ſaving, method of proceeding is, that of having ſuitable experienced perſons appointed in every townſhip or diſtrict, or for a certain extent of road, for the expreſs purpoſe of ſeeing what parts are in a bad condition, where water ſtagnates, or deep and improper ruts are formed, and to repair and remove them as expeditiouſly as poſſible.

In filling up and repairing the hollow parts, as well as the tracks which are formed by carriages, care ſhould conſtantly be taken that all the water be previ-

* When made of iron, from 20 to 40 lb. per yard is the uſual weight: 33lb. is ſufficient for carrying two tons. A bar of bet-iron, one inch and half in breadth and $\frac{1}{8}$ of an inch in thickneſs, is ſometimes fixed on wooden ſleepers for the ſame purpoſe.

ouſly well drained off, and the looſe mud or earth effectually removed. In ſome caſes, however, wheel-tracks may be reſtored to a proper ſtate, merely by the removal of their ſides, without any filling up; but the ſubſtance thus removed is highly improper for being depoſited in the ruts again, being of too ſoft and earthy a nature for ſuch repairs. Indeed, the common practice of throwing down the ſides of wheel-ruts in order to render them level, is but a very tranſitory and ineffectual repair. Suitable hard materials ſhould always be had recourſe to in ſuch caſes.

In conſtructing and repairing roads, it is alſo a circumſtance of more importance than is generally ſuppoſed, that the quality of the hard materials ſhould be as nearly equal as poſſible, and that where ſtones are employed, that they be broken down as much as can be to an equality of ſize; for it is well known that where the ſize of the ſtones made uſe of is various and unequal, the road will wear in holes and uneven. This is ſufficiently ſhewn by what happens in a road when ſtones lie at or near the ſurface which are larger and of harder qualities than thoſe of which the reſt of the road is compoſed, as hollows or depreſſions are conſtantly produced by the oppoſite wheel to that which paſſes over ſuch ſtones. This alſo affords a reaſon for removing every thing out of roads that has any tendency to throw carriages of any kind too much on one ſide, and for immediately filling up and repairing the parts of wheel-ruts which are more cut down on one ſide than the other.

Where gravel or ballaſt is employed, it ſhould, likewiſe, be as equal as poſſible, and well freed from clay, and all ſorts of earthy materials that it may contain. This ſeparation might probably, in ſome caſes, be greatly promoted by having the gravel dug in the autumn, and letting it be once or twice turned over during the winter, after having been thoroughly moiſtened, in order that it may be expoſed to the action of the froſts, in a ſtate the moſt ſuitable for being broken down and ſeparated. In regard to the ſize of the ballaſt that is made uſe of in repairing roads, though it is common to require it large, ſuch as is of a middling equal ſize is, in general, to be preferred, as binding better and ſooner on old roads.

In the winter ſeaſon nothing ſhould be done to roads in the way of repairs, except in caſes of neceſſity, ſuch as the reſtoring of places that may have ſuddenly given way, or been much cut up. The mud and ſtagnant water on the ſurface muſt, however, be conſtantly attended to and removed; and proper materials may, during this ſeaſon, and eſpecially when there is a hard froſt, be collected and carted to ſuch ſituations as may require them when the ſummer advances, which is the proper time for making and repairing roads. But in

doing this, unleſs the repairs are to be immediately performed, ſuitable places ſhould be provided for them, inſtead, as is the common practice, of depoſiting them in heaps on the ſides of the roads.

About the latter end of March, or beginning of September, when ſuch periods are ſufficiently dry for the buſineſs, is by much the moſt proper for putting freſh materials upon roads, as they are then not prevented from binding or becoming firm, either by too great drought, or too much wetneſs. In the firſt a moderate coat, where it is wanted, ſhould be laid on, and in the latter a more full and complete one. But before any ſort of material is applied, the road muſt be well ſcraped and cleaned, and the hollows and ſoft places, after being ſcooped out, and the bottoms well looſened, filled up level with good hard materials, rammed in by means of a heavy rammer. In this way ſuch places are rendered as hard and firm as any other part of the road. In the application of the ſurface materials afterwards, great care ſhould be taken that they be ſpread out as equally as poſſible over the whole.

By rolling with a heavy roller, as has been already noticed, much advantage may be derived in the reparation of roads, eſpecially if the hard part of the materials thrown out by the preſſure of wheel-carriages, be reſtored previouſly to the operation of ſuch a roller; as it can hardly be ſuppoſed that materials, however good, when put on in a looſe manner, can remain in their ſituation, or be durable, though it is a practice too commonly followed by the overlookers of roads, who but ſeldom employ any kind of inſtrument for the purpoſe of conſolidating the materials they apply in making repairs. If this mode was made uſe of at an early period, before any very large portion of the gravel or other matter was removed, in many caſes no other means whatever would be neceſſary.

With a view to reſtore the ſtones, gravel, and other materials, which may have been thrown up or diſplaced by the action of different kinds of wheel-carriages, implements of various ſorts have been propoſed; but the common rake and ſpade, in the hands of an expert labourer, are probably the beſt. The *road-harrow*, invented by Mr. Harriott, ſeems to anſwer pretty well where roads are repaired with ſmall ſtones or gravel. The inventor aſſerts, that "a man, a boy, and two horſes, will do three miles in length in one day, completely harrowing down the quarters, and drawing the ſtones together, which, by means of the mould-boards, are," he thinks, "dropped into the ruts, far better than a man can ſtub them in."

Where ſuch a machine can be uſed, the ſaving of expence may, of courſe, be very conſiderable; a repreſentation of it may be ſeen by conſulting the annexed plate. Rolling in the manner that has been already deſcribed ſhould, however,

conſtantly be had recourſe to after the uſe of this harrow, in order to make good work, or render the road ſufficiently firm and ſolid.

In making the repairs of roads, the choice of materials muſt chiefly depend on the facility of their being found, and the convenience of conveying them. On the principles which have been laid down, it muſt be evident, that a good foundation for a road is a *ſtratum* of any porous ſubſtance, ſuch as ſand, or ſandy gravel, or even the refuſe of free-ſtone quarries. The harder materials being then applied, the beſt of which are ſtones broken very ſmall and evenly, or gravel, and the more hard and brittle the ſtones are the better. One load of ſtones prepared in this way is ſaid to be more valuable in repairing roads, than three loads of ſuch gravel as is taken from the beds of rivers, or from commons, as it furniſhes a firmer bottom, at the ſame time that the ſurface is more equal, uniform, and durable. Where other ſtones can be procured, thoſe of a calcareous nature ſhould, however, never be employed, as they ſoon moulder down, and undergo a ſort of decompoſition, by which a kind of clay is produced, that in wet ſeaſons renders the roads extremely dirty, and cauſes them to retain water on their ſurfaces, which is prejudicial in a very high degree. Where ſmall ſtones are made uſe of as the finiſhing coat, they ought always to be thinly ſpread over with fine gravel or free-ſtone ſand, in order that the crevices may be well filled up, and the road be thereby rendered more durable.

Where roads are repaired with ballaſt, after the holes, tracks, and hollow places, have been properly filled up, and the water well drained off, as already noticed, a ſlight covering, in places where it is wanted, after the foundation or ground has been well looſened at the bottom, ſhould be applied at the times, and in the manner ſtated above. If roads repaired by this ſubſtance be covered too ſoon in the year, it is, however, apt to be too much reduced before the winter ſets in, which is the time they ought to be in a good and firm ſtate.

In the forming and repairing of communication parochial or private roads, attention ſhould conſtantly be had to the different principles and circumſtances which have been detailed in conſtructing thoſe of a public nature. Under the preſent ſyſtem of management, in theſe caſes little improvement is, however, to be expected, as the means are far from being ſufficient for the purpoſe, and thoſe who have the temporary direction of them, are ſeldom ſufficiently well informed in reſpect to the nature and principles of conſtructing or repairing ſuch roads, to perform the buſineſs to the greateſt advantage. Indeed, until the veryinadequate and inefficient plan of ſtatute labour be completely done away, and a ſuitable equivalent in money raiſed, and at the ſame time perſons of knowledge, experience, and information, with proper ſalaries, be appointed for manag-

ing the expenditure and application in each diſtrict, under the control of the acting magiſtrates for the time, or ſome ſuch power, it is almoſt utterly impoſſible that ſuch roads can be either made or kept in a good ſtate of repair. Mr. Donaldſon, in his "Modern Agriculture," has thrown out ſome hints on this ſubject, which are not, perhaps, unworthy of attention. After recommending the abolition of thoſe ancient ſtatutes that regulate the performance of ſtatute labour, he adviſes that in every county the juſtices of peace be inveſted with power to aſſeſs the inhabitants of the diſtrict by ſome equitable ratio, whereby they may pay only in proportion to the benefit they receive. "Were this generally done," ſays he, "as is the caſe in ſeveral parts of Scotland; the counties divided into diſtricts of ſuch ſize, that the proprietors could conveniently meet as occaſion required; the money ariſing from the commutation act collected by one perſon, who ſhould be allowed a certain *per centage* on the ſum collected, be continued during good behaviour, and be reſponſible for his conduct to the gentlemen of the diſtrict; the money ſo collected be afterwards expended under the direction of theſe gentlemen, and the whole be ſubject to the review of the quarter-ſeſſions;—the pariſh roads in theſe kingdoms would," he thinks, "ſoon be materially improved. If to theſe regulations a power were added to mortgage the ſum ariſing from the commutation of the ſtatute labour for ſuch a number of years, and to ſuch an extent as was found neceſſary to put the uſeful private roads in a complete ſtate of repair, they might, in a few years, be made the reverſe of what they are at preſent. This laſt meaſure would," he conceives, "be found the moſt effectual that could poſſibly be adopted, and is, probably, the only one that can be reſorted to for the purpoſe of effecting an immediate and general improvement."

But, whatever methods or plans may be thought the moſt advantageous and effectual, in removing the inconveniences which have ſo long been complained of, in the badneſs of parochial roads, it is obvious that, in addition to this, they muſt have conſiderable effect in improving the ſtate of agriculture, by leſſening the quantity and expence of labour, as well as by facilitating the means of conveying certain kinds of materials, without which the attempts of the farmer in carrying on improvements, muſt often be very circumſcribed and ineffectual.

In general, private or parochial roads are made ſo narrow as to admit of carriages paſſing one another with difficulty, except in particular places. They are alſo, in many inſtances, extremely circuitous and winding, by which much time is loſt in the carting of materials. The ſide drains are ſeldom ſuffici-

ciently opened and kept clear, on which accounts the roads ſuffer conſiderably, as from large quantities of water ſtagnating upon them, deep ſloughs and ruts are readily formed.

Roads have been ſuppoſed to be ſubject to much injury and deſtruction from ſome particular forms of wheels; thus broad ones, though conveying immenſe weights, have been recommended and encouraged, in preference to thoſe of the narrow kind, which carry comparatively but a very light load. But it is not the breadth of the wheels which ought excluſively to be conſidered, but the form or conſtruction of them, and the weight of load that is placed upon and carried by them; as it is clear from the effects which are produced, that the materials of roads cannot be rolled down flat, or left in a perfectly ſolid ſtate, by wheels proceeding in ſtraight directions, except where they have a cylindrical form of rim, and do not convey very weighty loads. The wheels of waggons, and other heavy carriages, though they have been required to have a certain breadth of rim, and a flat bearing on the road, have not been conſtructed in ſuch a form as is beſt ſuited to conſolidate, roll down, and keep the ſurface of roads in repair. The ſoles or rims of them, inſtead of being cylindrical, have moſtly been the portion of a cone, the properties of which have lately, by various experiments, been ſhewn to be thoſe:—of their having a natural tendency, in rolling, to revolve in a circular direction round their conical centres; of their requiring a conſtant power or force to keep them to a ſtraight line or courſe; in their being confined or compelled to move in ſuch ſtraight direction, a rubbing and friction occurring at the rim; their augmenting friction on the axis; their cauſing a rubbing againſt the ſides of deep ruts or tracks; their throwing up dirt from the hind part of the wheel; their pulverizing and greatly reducing the beſt ſorts of materials in dry ſeaſons, thereby cauſing much ſludge in wet, and much duſt in dry weather; their deranging and breaking the texture of the ſurface of the roads when in a ſoft or compreſſible ſtate, and leaving them in a broken condition, ready to imbibe moiſture, which cauſes all the bad effects of wet ſeaſons and intenſe froſts; their promoting the deſtruction of paved roads, by forcing open the joints and letting in the water under the ſtones, which by ultimately floating and diſcharging the gravel, renders the ſtones looſe and permits the pavement to ſink into holes; their augmenting the labour of the cattle or team, and accelerating the wear of the tyres of the wheels by their conſtant tendency to drag and grind on the roads*.

The cylindrical form of rims is ſhewn to be free from theſe inconveniences, having a conſtant tendency to proceed in a ſtraight direction, without friction

* Cumming in Communications to the Board of Agriculture, vol. II.

or rubbing at the circumference, or againſt the ſides of deep ruts; not throwing up dirt by the hind part of the wheel; not increaſing friction on the axis; not having preſſure againſt the lynch-pin; the ſole obſtacle to their proceeding in a ſtraight line, ariſing from the compreſſing and levelling the materials over which they paſs; have no diſpoſition to diſplace or break up the texture, or prevent the conſolidation of the parts of the roads on which they run; their frequent rolling on compreſſible ſubſtances rendering them more level, compact, and impenetrable to water, leaving them in a condition more favourable for conſolidation, and by contributing to keep the *interior* and ſofter parts of the roads dry, they are more enabled to reſiſt injury, and ſupport the cruſt that is the protection of them; have not the effect of opening the joints in paved roads, but, on the contrary, to improve them by operating as a rammer on the ſtones over which they paſs, from the *dead preſſure* ariſing from the equal velocity of all the parts; and advancing in a *ſtraight courſe* with the leaſt poſſible reſiſtance, and with greater advantages than any other ſhape, ſerve equally to improve roads, relieve cattle, and preſerve the tires of wheels*†.

* Theſe being the different effects of the conical and cylindrical form of the rims of wheels on roads, it is obvious that the latter muſt be much more beneficial in preſerving them than the former, and that the advantage gained by the uſe of them, will be proportioned to the extent of the ſurface over which they roll. Taking the difference in the effects between the conical and cylindrical form of the rims of wheels, at the rate of only one ſhilling for every acre of road rolled with the latter inſtead of the former; it is ſuppoſed by Mr. Cumming, that the probable amount of the advantage that may be thus obtained to the nation annually, by the wheels of "ſuch waggons only as travel the turnpike roads," would be as follows:

"The number of waggons in England is," he ſtates, "upwards of 96,600: and ſuppoſing that a tenth only of that number be employed on the turnpike roads, and a fourth of that tenth, or a fortieth of the whole, have wheels twelve inches broad; and of the remaining three-fourths, that one half have wheels ſix inches broad, and the other half, wheels only four inches; the ſtatement of the whole will be this:

Number of waggons employed on the roads - - -		9,660
Waggons with 12-inch wheels - - -	2415	
Ditto with 6-inch wheels - - - -	3622½	
Ditto with 4-inch wheels - - - -	3622½	
		9,660

"A wheel

† Cumming in Communications to the Board of Agriculture, vol. II.

The various facts, obſervations, and experiments, on which theſe very uſeful and intereſting concluſions are founded, can only be well underſtood by conſulting the valuable paper alluded to above; but the reſults of the different experiments are ſhewn in one point of view, and ſo arranged in the following table, that thoſe made under a ſimiliarity of circumſtances, both with the conical and cylindrical wheels, may be eaſily brought into a ſtate of compariſon. Thus the firſt column, A, furniſhes the number of each experiment, in the order in which they were made, for the purpoſe of referring to them when neceſſary. A deſcription of the particular circumſtance under which each experiment was attempted follows. The column B explains the number of weights which were required to draw the carriage under ſuch a combination of circumſtances, in ſuch a manner as juſt to *begin its motion* without being aſſiſted. And the laſt column, C, exhibits, on the ſcale of acceleration, the number of ſpaces that the carriage advances after the weights have ceaſed to act upon it;—which it is obſerved, "by eſtimating each diviſion on the ſcale as equal in value to *one-tenth of the weights that draw the carriage*, we aſcertain how much the reſiſtance to the

"A wheel twelve inches broad, will, in rolling thirty miles, cover a ſpace of 158,400 feet; and the four wheels of a waggon rolling a double ſurface will, at the ſame rate, in a day's journey, roll a ſurface of 633,600 feet, which is equal to the whole ſurface of four miles of a road thirty feet wide, and ſomething more than fourteen and a half acres; but rejecting fractions, and taking fourteen and a half acres as the quantity, the reſult in acres will be as follows:

2415	waggons, with 12-inch wheels, will, in a day's journey of thirty miles, roll - - - - - - - -	35,012
3622	waggons, with 6-inch wheels, will roll - - - -	26,259
3622	waggons, with 4-inch wheels - - - - -	17,506
	The number of acres rolled in a day by all the waggons -	78,777

"And ſuppoſing all the waggons, at an average, to travel only ninety days in the year, they will roll a ſurface equal to 7,089,930 acres; which, at one ſhilling per acre, will exceed *three hundred and fifty thouſand pounds* per annum.

"But, waving pecuniary eſtimates, let it," ſays he, "be remembered, that the quantity of ſurface that is rolled once yearly by the waggons that travel the roads of England, is equal to the *entire ſurface* of 1,948,880 miles of road thirty feet wide. It is ſurely then," he thinks, "of importance to enquire, whether the wheels that roll this very extenſive ſurface, tend to improve or impair it? It is to be obſerved, that no notice is here taken of the waggons that are ſuppoſed to be employed for the purpoſes of agriculture, &c. nor of the immenſe number of carts, coaches, &c. that travel the public roads."

progreſs of the carriage is leſs than the power by which it is drawn *in decimals of that power*.

TABLE OF EXPERIMENTS.

A. Number of the experiments according to the order in which they were made.	The circumſtances under which the experiments were made, with the different ſets of wheels.	B. Number of weights required to make the carriage begin its motion.	C. Number of ſpaces which the carriage advances after the weights have ceaſed acting.
1ſt.	The Conical Wheels bearing on their whole breadth, were drawn by -	9	0 1/2
4th.	The Cylindrical Wheels, do. do. - - - - -	6	3 1/2
2d.	The Conical Wheels bearing on a fourth of their breadth on the middle tire	6	1
5th.	The Cylindrical Wheels under the ſame circumſtance - -	6	2
3d.	The Conical Wheels bearing on two ſlips on the extremities of their rims	11	0
6th.	The Cylindrical Wheels under the ſame circumſtances - -	6	2 1/2
7th.	The Conical Wheels drawn on friction bars, that remove the friction at the rim	6	0 1/4
8th.	The Cylindrical Wheels on do. at liberty, but the friction bars do not move	6	1
9th.	The Conical Wheels on the friction bars (fixed) bearing on their whole breadth	9	0 1/4
10th.	The Cylindrical Wheels, do. do. - - - - -	6	0 1/2

The following important deductions are drawn from a compariſon of the effects of each claſs of wheels under ſimilar experiments, as ſhewn in the table, namely, that from " the *firſt* and *fourth* experiment," it ſeems evident, that the ſame load that is drawn on *conical wheels* by a power of nine, is drawn on *cylindrical ones* by a power of ſix; and that after the power has done acting, the carriage with the former kind of wheels proceeds only one *half a ſpace* on the ſcale of acceleration; while that with the latter ſort, though drawn by a third leſs power, has ſufficient *motion* left to advance it forward *three ſpaces and a half*.

That by the *ſecond* and *fifth*, it is clear that when the conical wheel is made to bear on a fourth part only of its breadth at the middle of the rim, it is drawn by a power of ſix, and proceeds *one ſpace*, after the acting power ceaſes; but that cylindrical wheels bearing on the ſame breadth, and drawn by the *ſame power*, advance on the ſcale *two and a half diviſions*; which ſhews that even the *narrow cylindrical* is drawn with more eaſe than the narrow conical wheel, and that the difference in favour of the former is, in this inſtance, equal to $\frac{3}{20}$ of the power by which the carriage is drawn. That the third experiment proves, that when the conical wheel bears equally on the oppoſite extremities of the rim, *eleven weights* are requiſite to draw it; that with this increaſed power, it ſtops the moment the action of the impelling weight ceaſes: the uniform reſiſtance to

its progreſs being equal to the uniform action of the power, no reſidue of motion is left to force it forward. That the *ſixth* evinces, that with the cylindrical wheels, bearing in a ſimilar manner on the extremities of their rims, *the ſame load* is drawn by *ſix* weights only; and the motion ſo accelerated as to carry the carriage two and a half ſpaces forward, after the weights have ceaſed to act upon it.

That the reſult of all theſe experiments, on the whole, ſhew that the greater reſiſtance which takes place with the broader conical wheels, does not depend on the breadth of the rim alone, but upon the breadth and the conical ſhape conjointly. That, in conical wheels, the *increaſe of reſiſtance* depends upon the difference of the velocity of the greateſt and of the ſmalleſt parts of their circumference, and that the exertion of the cattle muſt neceſſarily increaſe in the ſame proportion. That, the reſiſtance is increaſed on the ſame conical wheel, when the preſſure of the load is confined to thoſe parts of the rims that have the greateſt difference of velocity. That, on the ſame principle, the reſiſtance with the conical wheel *on a hard bottom*, is diminiſhed by narrowing its bearing; but that on yielding ſubſtances, the effect is directly the contrary. That, ſince this friction and dragging of the conical rim is owing to the different velocities of the ſeveral parts of the circumference, it follows, that every wheel which has not an equal velocity in every part of its circumference, muſt have a dragging and unneceſſary reſiſtance, that is, a reſiſtance that may be avoided by giving to every part of the circumference, or rim, the ſame degree of velocity. That, the only means by which an equal degree of velocity can be obtained in every part of the circumference of a wheel, is, by making all the parts exactly of the ſame diameter; and every wheel that has all its parts of the ſame diameter, muſt neceſſarily be *cylindrical*. And thus, that the concluſions from the reſult of experiments, and from theory, concur in proving, that ſo far as regards the labour of cattle, or the facility of the progreſs of carriages, the cylindrical ſhape of a wheel is preferable to any other poſſible ſhape: and that this ſuperiority of the cylindrical wheel, which has hitherto been illuſtrated by conſidering only the cauſes from which the greater reſiſtance with conical broad wheels ariſes, is further proved by the experiments that have been made with the cylindrical wheels; in each of which, *the ſame number of weights* were required to make the loaded carriage begin its motion, under the ſame variety of circumſtances, which with the conical wheels occaſioned the difference ſhewn in the table, in the number of the weights required to draw the ſame load; and the number of weights that were capable of drawing the loaded carriage under each of thoſe various cir-

cumſtances on the cylindrical wheels, was only equal to the leaſt that was required with the conical; and when the conical wheels bear on the extremities of their rims, five more weights are required with them than with the cylindrical wheels. And that, although no difference appears by the number of weights required to begin the motion of the carriage with the cylindrical wheels, whether they bear on the whole breadth of the rim, on a narrow part of its middle, or on the extremities of the felloes; it ſeems clear by the ſpaces which the carriage advances, on the ſcale of acceleration, after the weights have done acting upon it, that when the cylindrical wheel bears on its whole breadth, it advanced on that ſcale $3\frac{1}{2}$ ſpaces, when bearing on one-third of its breadth only, it advanced only $2\frac{1}{2}$ ſpaces; and when bearing on a fourth of its breadth only, it advanced no more than 2 ſpaces: here then, it is obſerved, is ſeen a moſt important difference between the cylindrical and the conical wheel; namely, that *the broader the bearing of the cylindrical wheel*, the more eaſily it proceeds, and that the broader the bearing of the conical wheel, the greater is the reſiſtance to its progreſſion*.

On theſe grounds and principles it is ſuggeſted, that the uſe of low broad cylindrical wheels, with light carts, may be advantageous for many purpoſes of the farmer, ſuch as conveying manure on tillage and meadow land, in all kinds of ſeaſons.

And the ingenious writer concludes that, on the whole, cylindrical wheels muſt therefore be beneficial to the proprietors of waggons, by their leſſening the labour of the cattle on the *ſame road*, as well as keeping the roads in a more improved ſtate of repair; and to the *truſtees* of roads, by their improving them, and rendering leſs expence in repairs neceſſary, independent of the leſs injury done to the roads uſed by the farmer.

In reſpect to the form or ſhape of roads, in ſo far as the effects of wheels are concerned on them, it is evident, that as the effect of every ſhape of wheel, whether it be cylindrical, or of the conical and more rounded form of tire, muſt be that of forcing the materials of which they are compoſed *laterally*, and this in proportion to the ſupport which they have at the ſides. Roads ſhould not have too much of the convex or rounded form, having, under ſuch circumſtances, the leaſt ſupport at the ſides, to which, on that account, the materials are continually forced by the preſſure of carriages in the middle, where the great bulk of materials is uſually laid. It is in this way that convex roads ſoon become in a degree level.

* Cumming in Communications to the Board of Agriculture, vol. II. p. 408.

Wheels that have the greateſt elevation in the middle of their rims, or are the moſt rounded in their ſhapes, will have the moſt effect in this way, as well as in breaking up and deſtroying the cruſt or ſurface of roads, and of courſe muſt be the moſt prejudicial to them*.

As the goodneſs of roads, and the expences of keeping them in repair, are alſo conſiderably influenced by the nature of the fences that are made on the ſides of them, it may not be improper to take notice of a few circumſtances which reſpect them.

In caſes where the ſituation of the ground on the ſides of roads is ſuch as to allow of ſunk fences being made, they are unqueſtionably the beſt, as they contribute much to the keeping of them dry. They may be conſtructed in the manner of open ditches or drains, and of ſuitable depths, the deepeſt parts being conſtantly on the ſide of the fields. But where they lie open to the roads, this can ſeldom be done with ſafety. By having the fences and ditches formed in this manner, the foundation of roads may be more eaſily kept free from moiſture, and at the ſame time more ſpace be allowed for travelling upon, than in caſes where the ditches are conſtructed on the ſides of the roads.

Where the fences are formed of ſtone or ſod, or even of quicks, they ought not to be higher than two or three feet above the ſurface of the road; but if a pailing be made uſe of, it may with advantage be ſet higher. By keeping the fences low, the roads will be more expoſed to the action of the ſun and wind, and conſequently ſooner rendered dry, and free from the ſtagnation of moiſture. Wherever high hedges or trees grow on the ſides of roads, they keep them conſtantly wet and dirty; the former ſhould, therefore, be cut to the height of five or ſix feet, and the latter be either pruned cloſe to near the tops, or totally removed. Neither trees nor plantations of any ſort ſhould be planted ſo near the ſides of roads, as to prevent evaporation from rendering them quickly dry. Where trees are, however, to be planted in the neighbourhood of roads, the diſtance ſhould ſeldom be leſs than ten or fifteen feet from the fence, and forty or more from each other; in which caſes they muſt be protected while young from cattle by hurdles, or a pailing of ſome other kind.

* Cumming in Communications to the Board of Agriculture, vol. II.

Fig. 1.

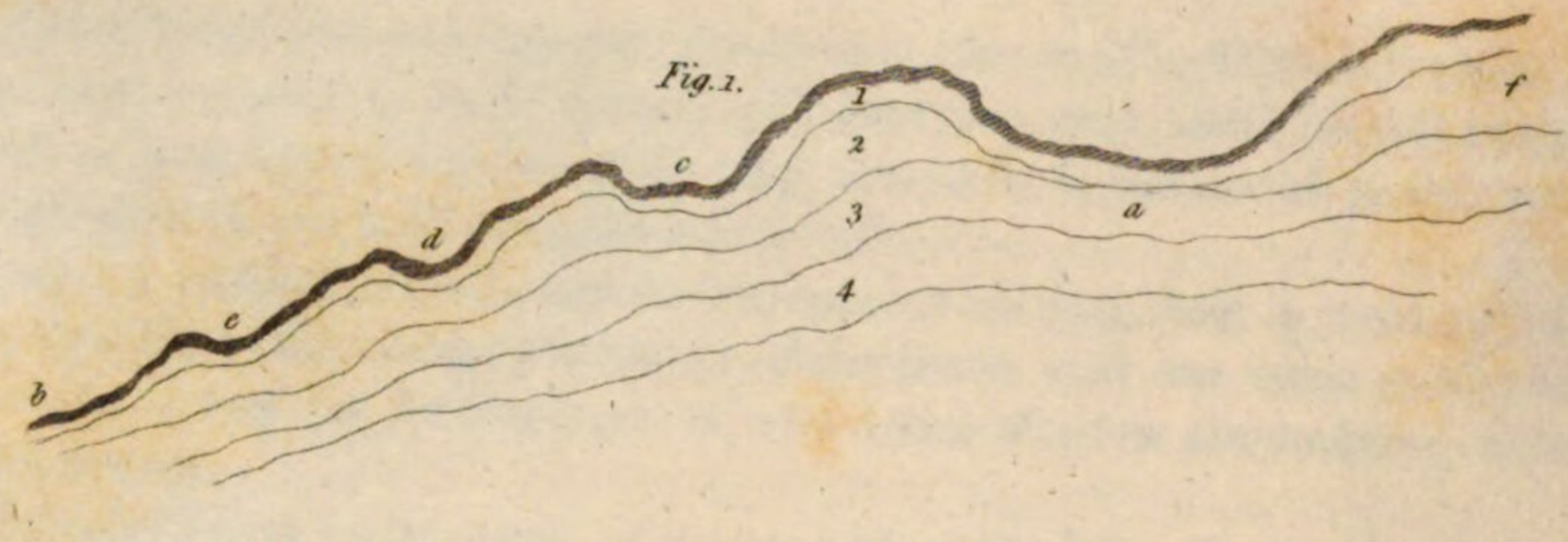


Fig. 2.

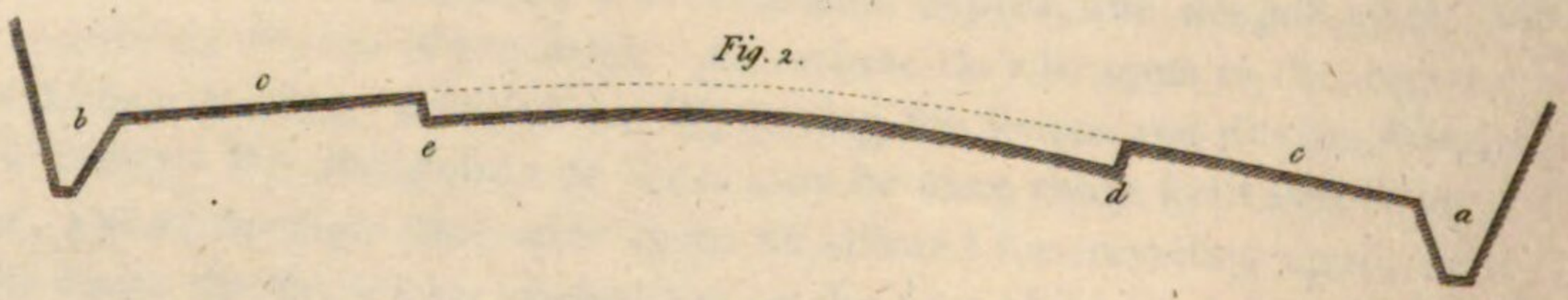


Fig. 3.

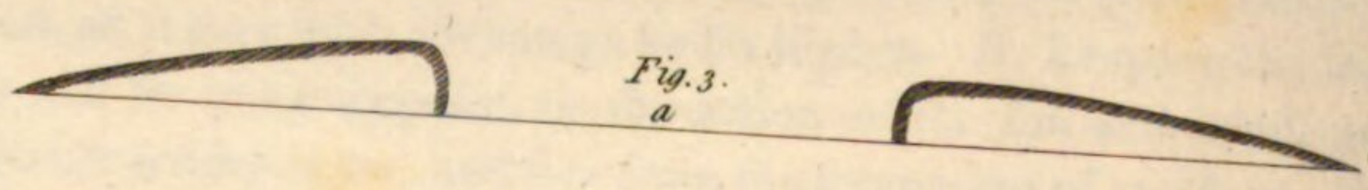


Fig. 5.

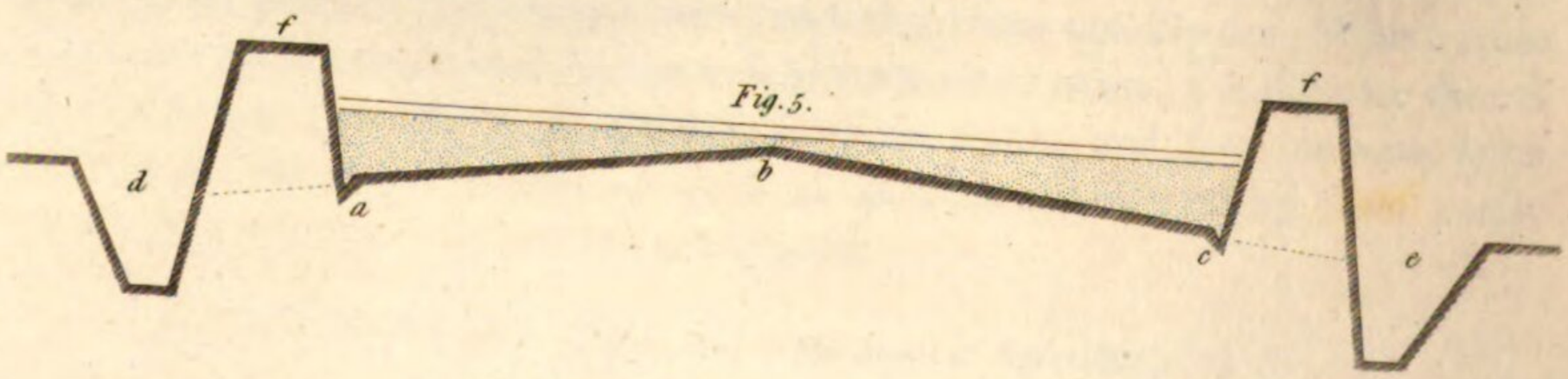


Fig. 4.

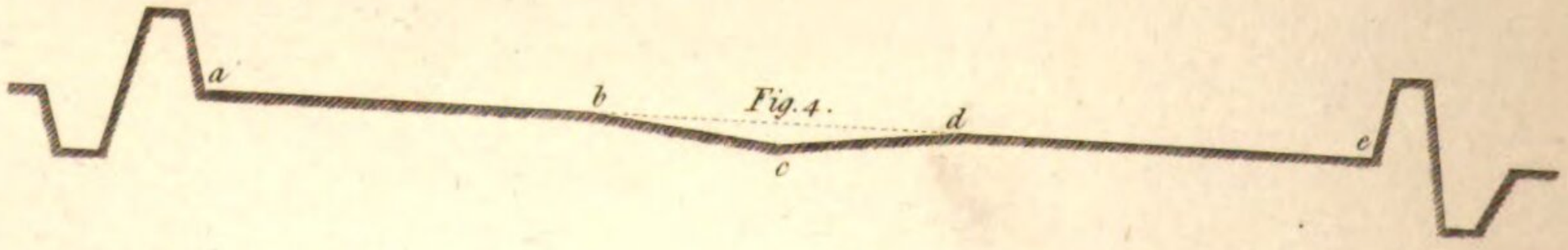


PLATE XXXV.

Conſtruction of Roads.

[*To face Page* 174.]

Fig. 1. REPRESENTS the ſtratified nature of the earth in the ſection of a hill or elevated ground, as 1, 2, 3, 4, &c. 1. The upper porous *ſtratum.* 2. The retentive ſtratum below, which confines the water until diſcharged at *b*: if the *ſtratum* 2 be hollow at *a*, and proceeds towards *f*, it then lodges in that hollow, forming ſoft ground there; but if at this hollow a communication is formed with the *ſtratum* 3, which is porous at *a*, no water will ſtand there, but penetrate through it to the impervious *ſtratum* 4, on which it glides till it finds vent on the ſide or bottom of the hill. It is evident in the figure, that if the upper *ſtratum* 1 be retentive, water falling on it will not only lodge in the large hollow *a*, but alſo in the ſmall ones, *c d e*, &c.

Fig. 2. Shows the manner of forming a convex road, in which *a* and *b* exhibit the ditches or drains on the ſides; *c c* foot-ways, or horſe-roads when ſufficiently wide; *d e* a convex line, ten or twelve inches lower at *d* and *c* than the foot-way. The ſpace ſhown by the dotted line is to be filled up with hard materials.

Fig. 3. Exhibits another plan of forming convex roads, in which *a* is the hollow in which the hard materials are depoſited, the bottom of which is flat inſtead of being convex as in the former, and of greater depth, conſequently requiring a larger proportion of materials.

Fig. 4. Repreſents an improved mode of forming roads, in which the lines *a b* and *b c*, inſtead of being convex, are quite ſtraight, meeting in an angle or ridge at *b*, ſloping to each ſide regularly about an inch in a foot: *a* and *c*, ſmall drains for conveying off the water collected at theſe places.

Fig. 5. Exhibits a croſs ſection of a concave road, in which the whole breadth *a e* of it is divided into three equal portions, as *a b*, *b d*, and *d e*, the ſides *a b* and *d e* being formed quite flat; but the part *b d* has a gradual ſlight deſcent each way to *c*, the middle of the road; it has alſo a ſlight deſcent in a longitudinal direction for conveying off the water at proper outlets; *b d* the place in which the hardeſt materials are laid. In this form of road there are three parts on which carriages can go, as *a b*, *d e*, and *b d*, in which the horſe-truck is at *c*.

CONSTRUCTION of ROADS.

Fig. 1.

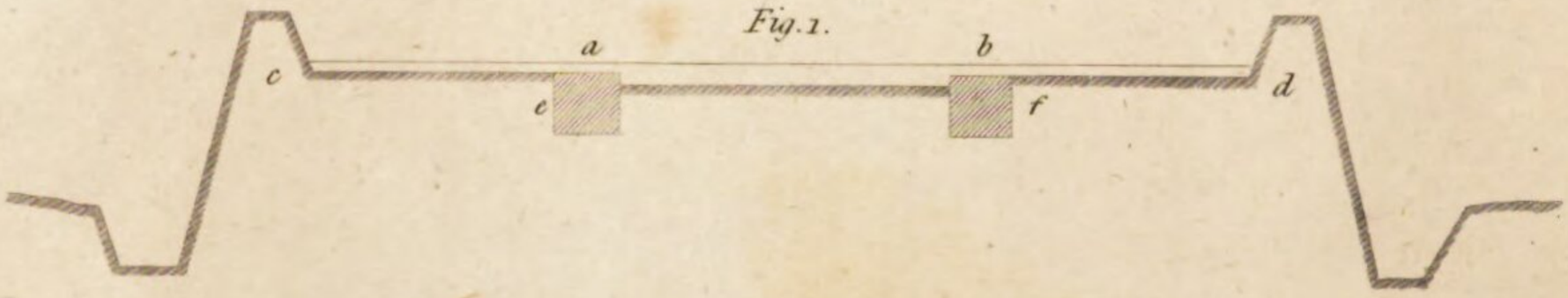


Fig. 2.

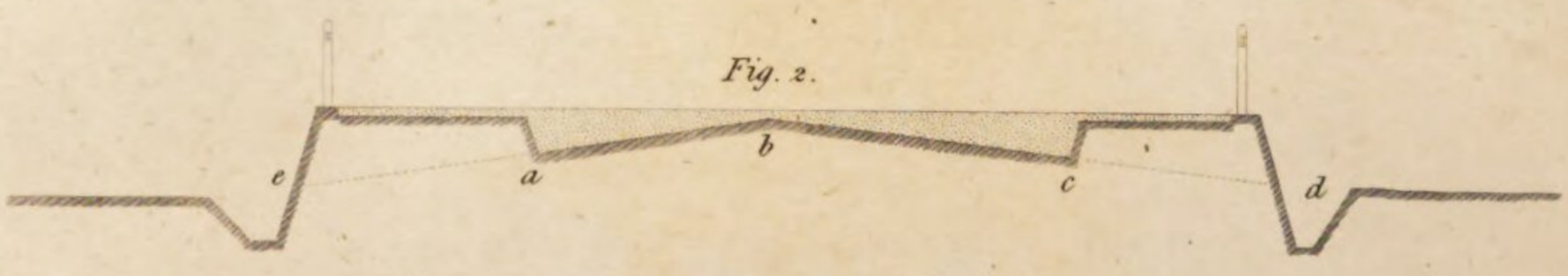


Fig. 3.

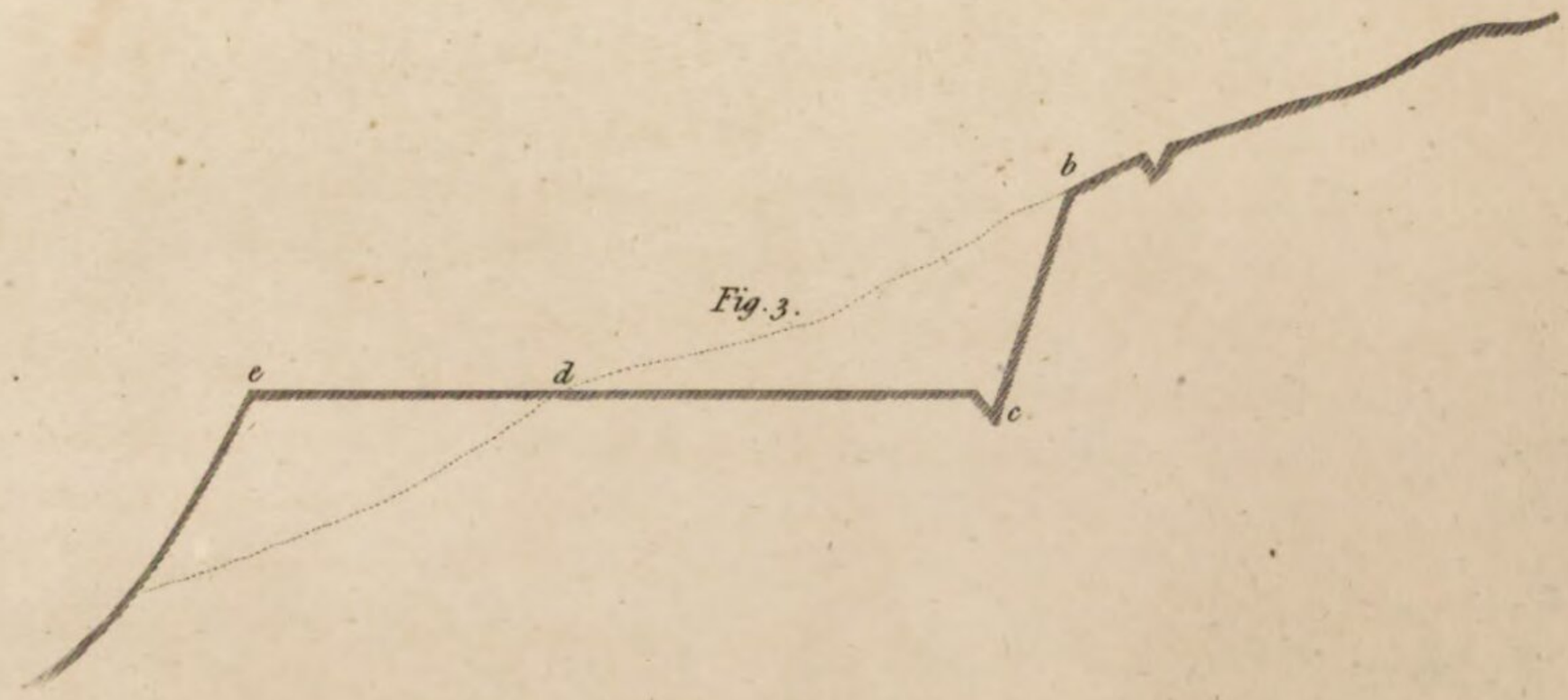


Fig. 5.

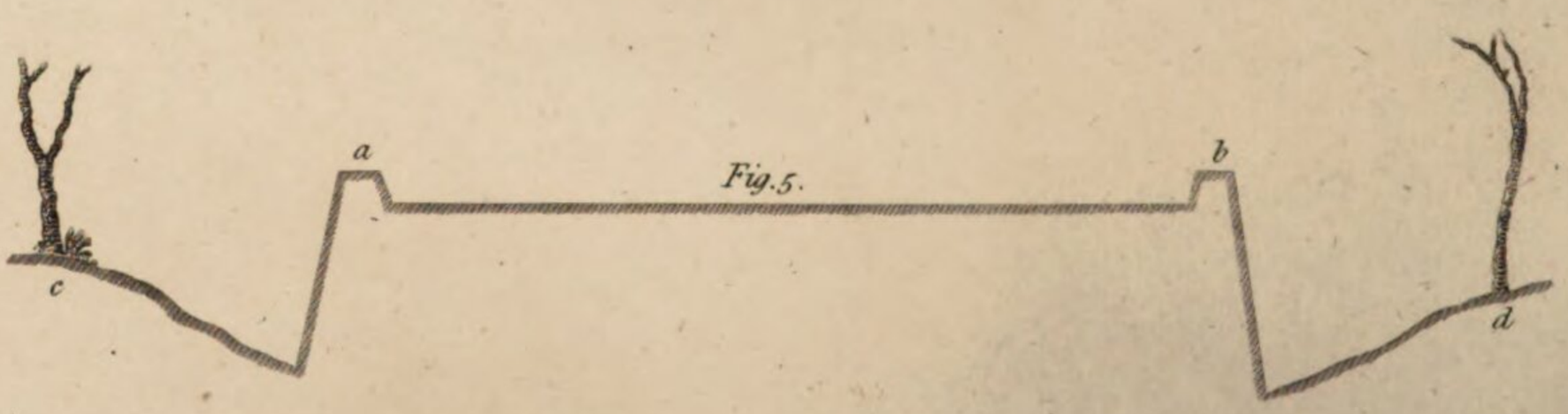


Fig. 4.

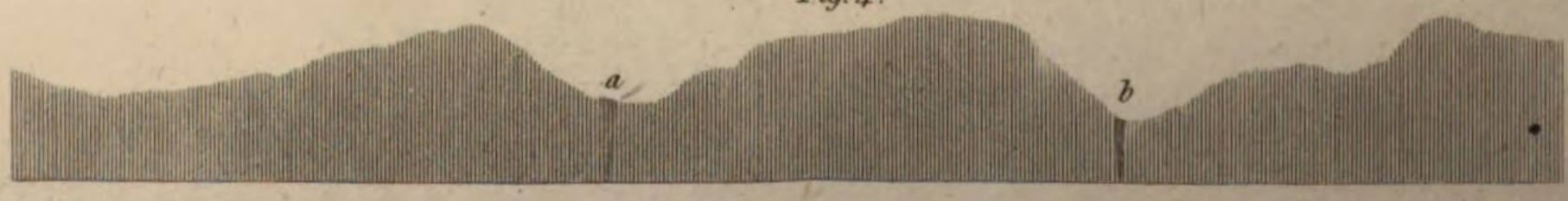


PLATE XXXVI.

Conſtruction of Roads.

[*To face Page* 174.]

Fig. 1. Is the repreſentation of the plan of a road made in a looſe ſandy ſoil. After forming it to the full width for the hard materials, dig channels, *a* and *b*, where neceſſary at each ſide, 18 inches in depth, with the ſame width, filling them up with ſolid materials, as ſhown at *e* and *f*, to prevent the others from ſpreading out laterally, which is the chief difficulty of forming roads in ſuch ſituations. It is recommended by Mr. Beatſon.

Fig. 2. Exhibits the form and method of making roads in clayey ſoils: *a b c* the clay hollowed out for the porous materials, ſo as to leave a ridge in the middle of it; the dotted lines, *e a* and *c d*, drains to conduct away the water at ſhort diſtances into the main drains *d* and *e*.

Fig. 3. Shows the form of roads made on the ſides of hills: *d c* the part cut out of the ſolid, which in moſt caſes will require no covering; *d e* the part made up, which at firſt ſhould be higher than the other; *b c* the face of the bank: the water from above ſhould be intercepted at *b* to prevent its being injured and the drain *c* being choked up. In irregular faced banks it may ſometimes be neceſſary to let off the water by wooden ſpouts ſunk upright in the banks at the hollows, as ſeen at *a b*, *fig.* 5.

Fig. 4. Explains the manner of planting trees near roads: *a b* the extent of the road; *c d* the planted trees.

IMPLEMENTS for repairing ROADS.

Fig. 1.

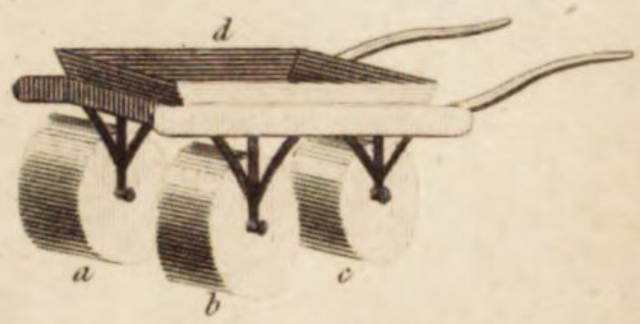


Fig. 2.

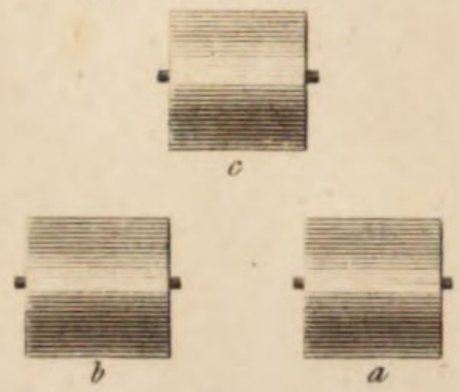


Fig. 3.

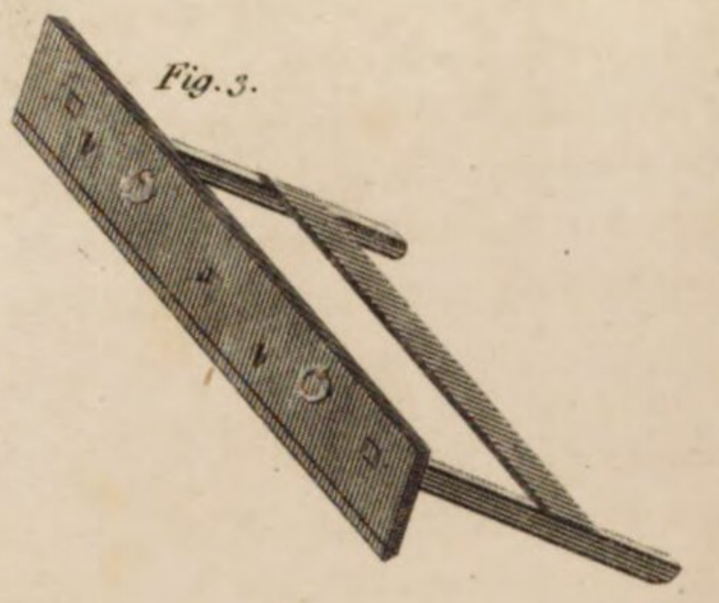


Fig. 4.

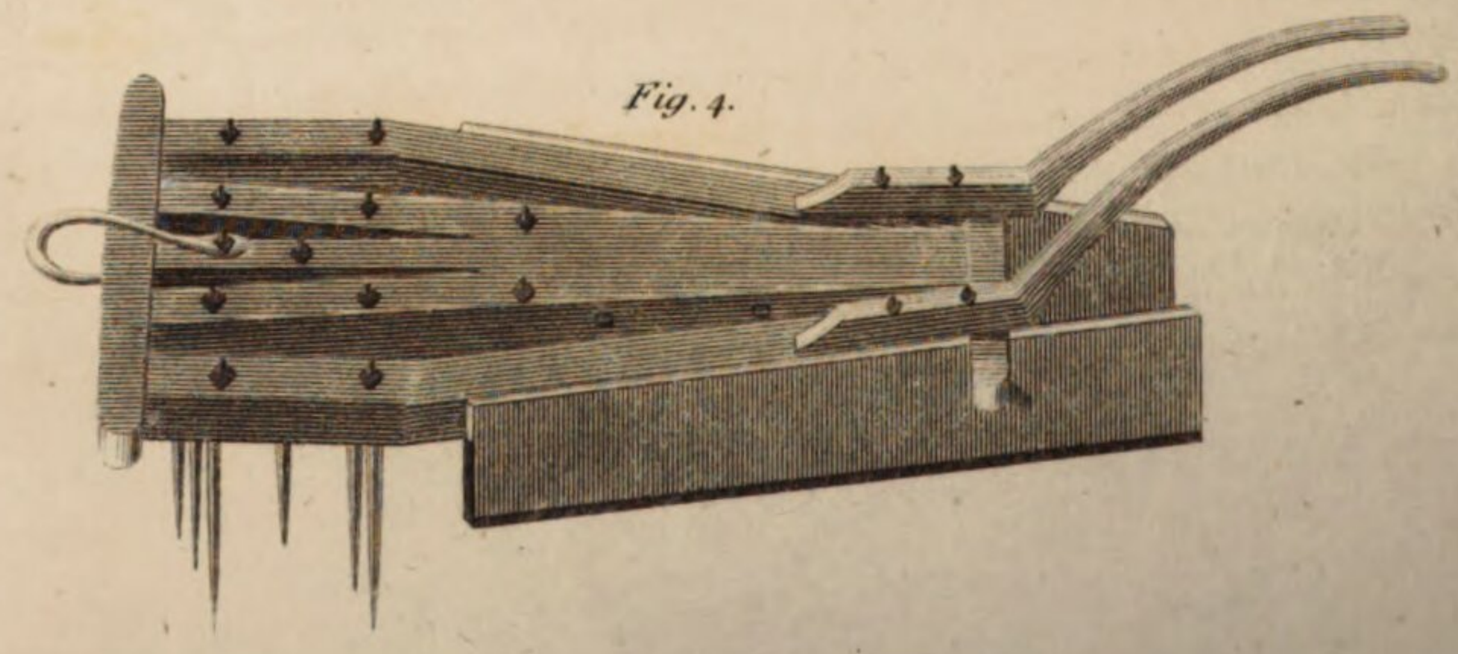


PLATE XXXVII.

Implements for repairing Roads.

[*To face Page* 174.]

Fig. 1. Repreſents an iron roller with three diviſions for the purpoſe of rolling new formed roads; in which *a* and *b* ſhow the two hind parts, and *c* the middle or front one to which the ſhafts are attached, and which are ſo conſtructed as to turn in the manner of the fore wheels of a waggon. *d* a box for containing ſtones to increaſe the weight occaſionally; two-thirds being placed over *a* and *b*, and only one-third over *c*, in order to make the preſſure equal. It has been recommended by Mr. Beatſon as very uſeful.

Fig. 2. The plan of the roller as ſtanding on the ſurface of the road, *a* and *b* the back, and *c* the fore or middle part.

Fig. 3. Is the repreſentation of an implement for the purpoſe of levelling the ſurface of roads, and is uſed in America, according to the Biſhop of Llandaff, for levelling ground. It is conſtructed of a ſtrong plank, *a*, five or ſix feet long, ſhod with iron on the inferior part, which has a ſharp edge for ſcraping the road as drawn upon it. A frame is fixed at the back of the board on which the driver ſtands, directing the horſe by two rings or hooks *b b*. It is recommended in this intention by Mr. Beatſon.

Fig. 4. Repreſents a harrow invented by Mr. Harriot of Great Stambridge, Eſſex. Its head is three feet in length from the outſides of the bars. The bars are four inches ſquare and five feet in length. The mould boards extend eleven inches further to draw the ſtones harrowed up nearer the middle of the road; and are four feet two inches long, ten inches depth, and two inches thick, ſhod with a bar of iron, and lined ſix inches with iron plate. The teeth are one foot in length from the under ſide of the bars, ſteeled at the point, and an inch and quarter ſquare, fixed in with nuts and ſcrews having collars both above and below the bars. The bars paſs in a longitudinal direction to guard againſt ſplitting. It is drawn by two horſes abreaſt, the outſide horſe on the outer quarter, and the other in the path, a man ſteadying the harrow by the handles. Thus an inſide and outſide quarter are taken in going, and the others in returning. It is ſuggeſted as an effective implement by Mr. Beatſon.

PLATE XXXVII.

Implements for repairing Roads.

[To face Page 174.]

Fig. 1, Represents an iron roller with three divisions for the purpose of rolling new formed roads; in which *a* and *b* show the two hind parts, and *c* the middle or front one to which the thills are attached, and which are to contracted as to run in the manner of the fore wheels of a waggon. *d d* are for containing stones to increase the weight occasionally; two-thirds being placed over *a* and *b*, and only one-third over *c*, in order to make the draught equal. It has been recommended by Mr. Beetson as very useful.

Fig. 2. The plan of the roller as floating on the surface of the road, *a* and *b* the back, and *c* the fore or middle part.

Fig. 3. Is the representation of an implement for the purpose of levelling the surface of roads, and is used in America, according to the Hints of Lieut. S. for levelling ground. It is constructed of a strong plank, *a*, five or six feet long, fixed with iron on the interior part, which has a sharp edge for scraping the road as drawn upon it. A tramp is fixed at the back of the board on which the driver stands, dividing the bottom by two strong hooks *b b*. It is recommended in this intention by Mr. Beetson.

Fig. 4. Represents a barrow invented by Mr. Elliot of Lower Shadwell, Essex. The head is three feet in length from the outside of the bars. The bars are four inches square and five feet in length. The mould boards extend on each side (forming the three barrows) up near the middle of the road; and are four feet two inches long, ten inches deep, and two inches thick, fixed with a bar of iron, and fitted six inches with iron plate. The teeth are one foot in length from the under side of the bars, fixed at the point, and an inch and quarter square, fixed in with nuts and screws having collars between and below the bars. The bars pass in a longitudinal direction to proper points for the handles, which are fixed by two bolts above, the curved part of the handles passing through the bars. The barrow is supported as an off-side wheel of a cart by the man steering the barrow by the handles, and the others in returning.

EMBANKMENTS.

Fig.1.

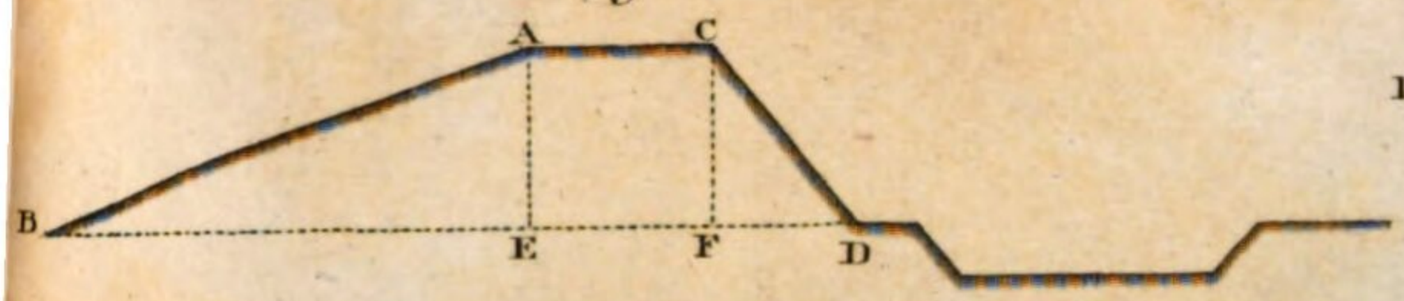
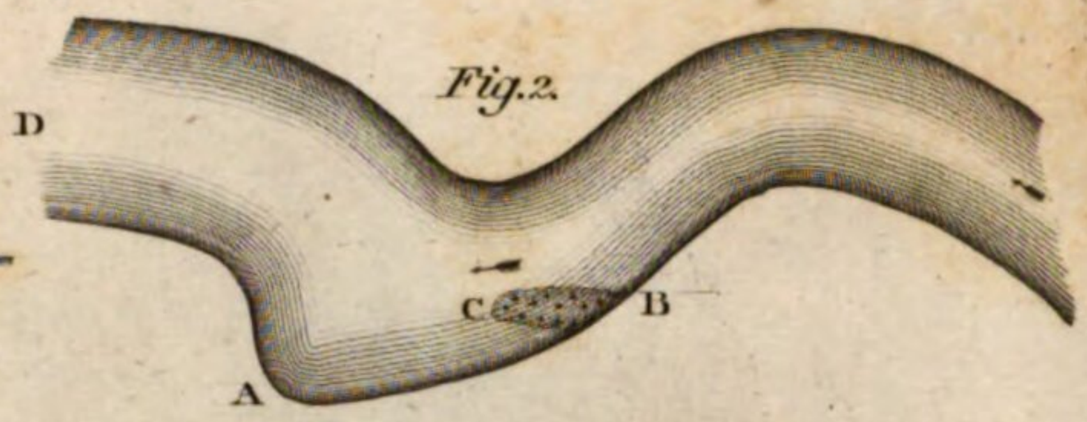


Fig.2.



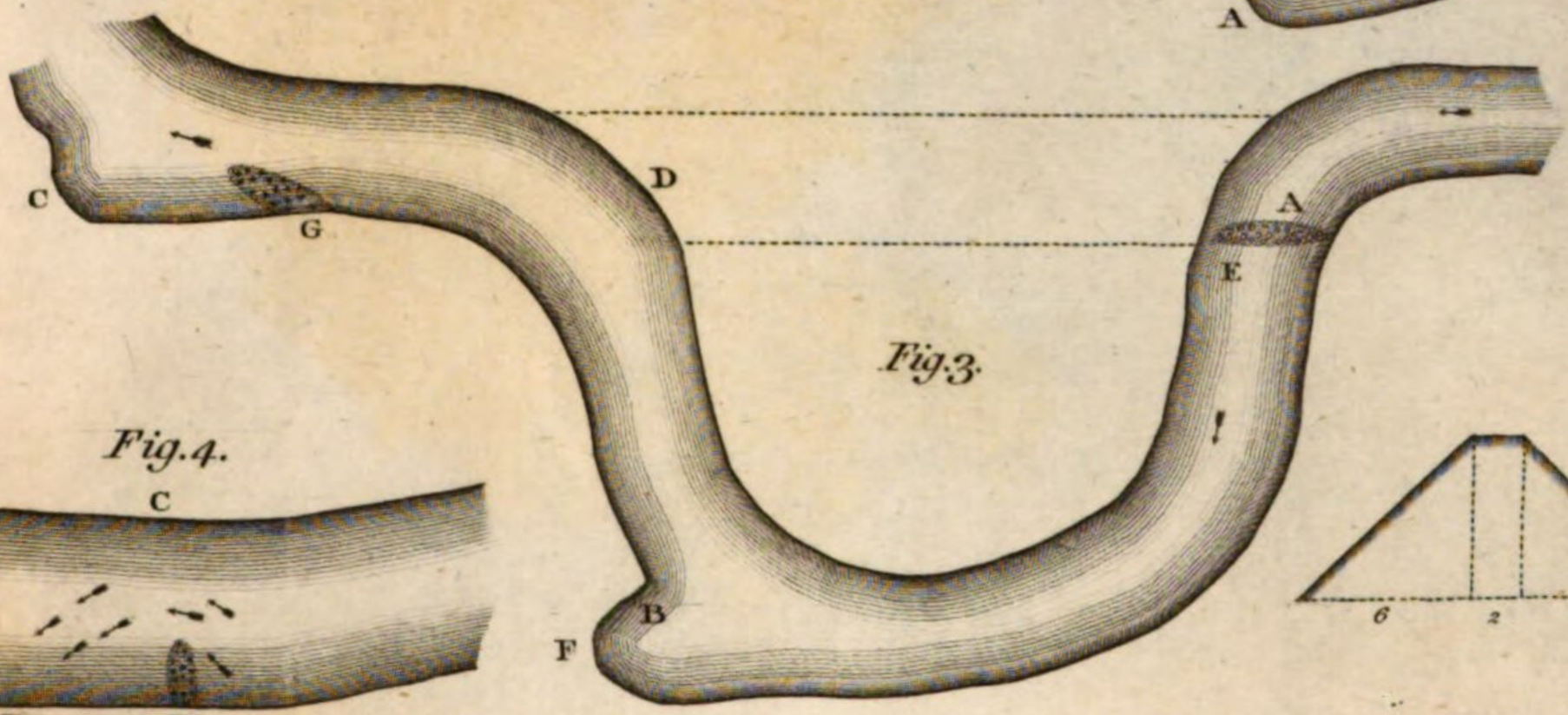


Fig.3.

Fig.4.

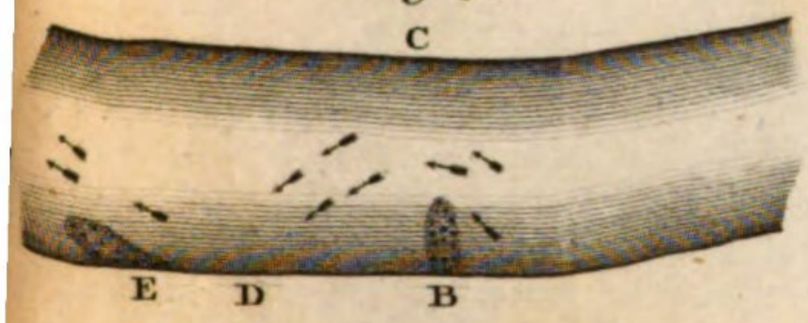


Fig.5.

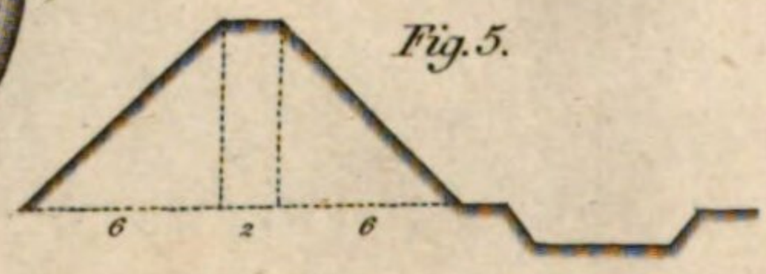


Fig.6.

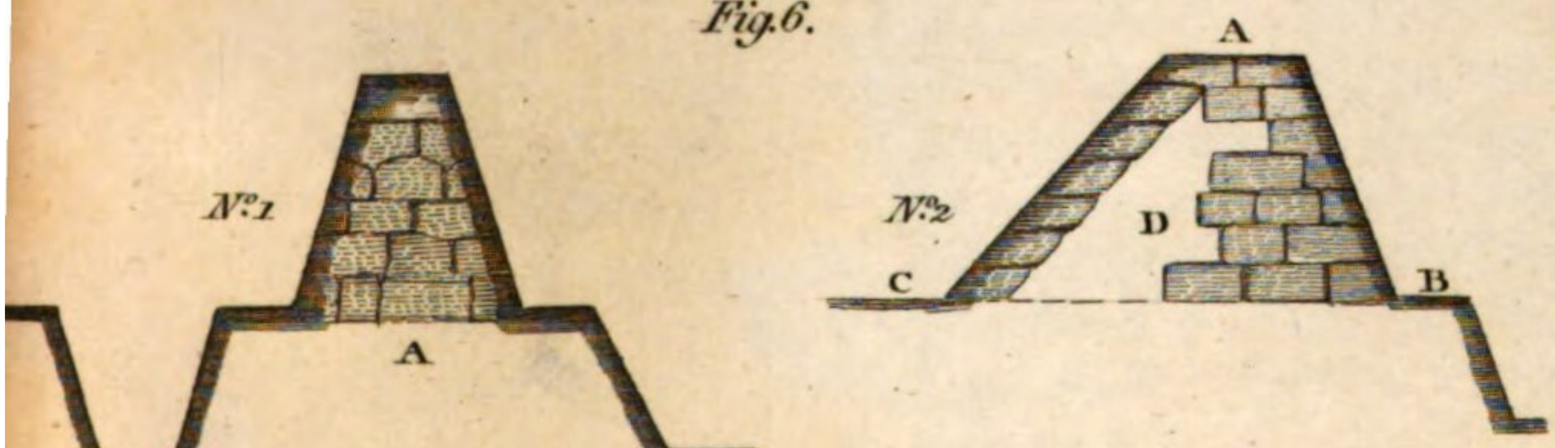
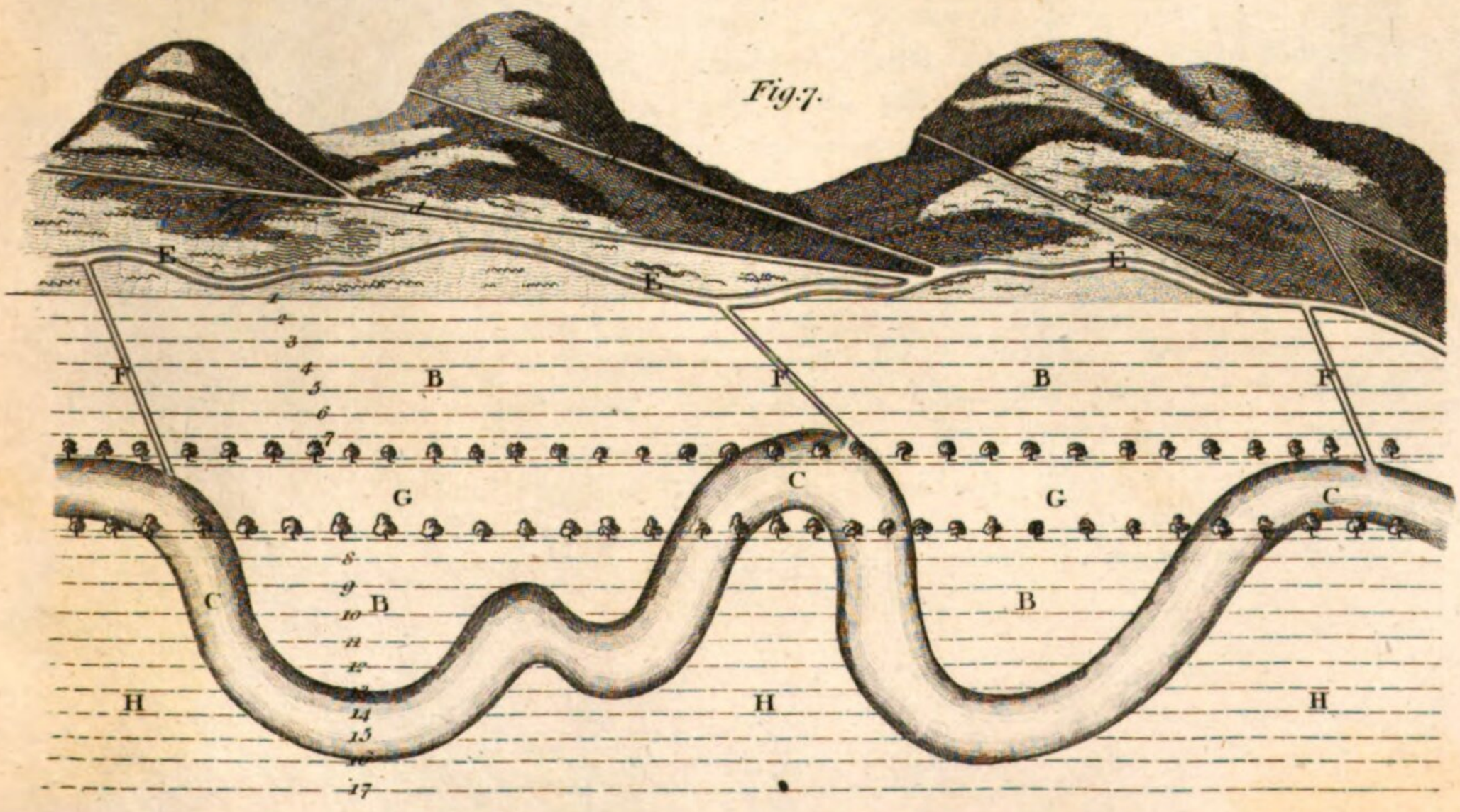


Fig.7.



Published Oct.r 22-1804. by R. Phillips St.Pauls Church Yard.

Strand.

PRACTICAL AGRICULTURE.

PART THE SECOND.

SECTION VI.

SOILS.

SOILS.—Manner in which they are formed—Reaſon of their Variation of Quality—Cauſe of their different Degrees of Fruitfulneſs—They are injured by ſome Subſtances—Kinds which have this Effect—Reaſons why thoſe which are apparently ſimilar, turn out different on their being broken up—Cauſes of the contradictory Facts reſpecting in Agriculture—Cauſes of Soils producing one Sort of Crop in preference to another—Depth and Quality of Subſoils—The Cauſe of Differences in—Cauſes of the Difficulty of aſcertaining—Methods in which attempted—Chemical Analyſis—Natural Appearances—Nature of Plants produced by—Advantages of each—Neceſſary to have Recourſe to Experience—Have been deſcribed under a Variety of uſeleſs local Terms—May be diſtinguiſhed under a few Heads—Clayey Soils—Cauſes of the Differences of—Circumſtances to be attended to in improving them—Applications moſt uſeful for—Methods of laying them on—Advantage of proper Modes of Tillage in—Neceſſary to be kept as dry as poſſible at all Seaſons—Advantages of keeping them dry in different Caſes—Circumſtances to be attended to in their Tillage—Means of aſcertaining their Nature.—LOAMY SOILS—Admit of Variety—Subſtances of which compoſed—Manner in which they recede from Clays—Circumſtances on which their Lightneſs and Friability depend—On which their Colours depend—Admit of Improvement more readily than Clays—Applications proper in this View Reaſons for their being more eaſy of Tillage—Not ſo diſpoſed to the Production of Weeds.—CHALKY SOILS—Circumſtances which produce Differences in them—State of the calcareous Matter incorporated with them muſt be attended to—The Combination of other Subſtances with the calcareous alters its Effects—In Union with Magneſia is prejudicial to Vegetation—Cauſes which form Diſtinctions in—Applications ſuitable for improving them—Reaſons why much Strength of Draught is required in—Great Attention to the Tools employed on, always neceſſary.—SANDY SOILS—Mode of Formation of—On what the Variation of depends—Why leſs benefited than others by Heat and Moiſture—Circumſtances to be attended to in improving them—Applications proper in dif-

ferent Caſes—Reaſon why different Applications are uſeful in different Diſtricts—Means of ſupplying them with vegetable Matter—Methods in which Manures may be applied to them—Thin Soils eaſily cultivated—Cauſes of the Diſadvantages of.—GRAVELLY SOILS—Materials of which compoſed various—Different Arrangements of in.—Why ſubject to burn—Defects of, how removed—Applications proper for in different Caſes.—PEATY OR MOSSY SOILS—Met with extenſively in ſome Diſtricts—Cauſes of the Varieties of—Stratified Order of—Cauſe of great Differences in—Highly retentive of Water—Injured by its Evaporation—Means of Improvement in—Applications neceſſary for.—VEGETABLE EARTH OR SOIL—Nature of, in different Caſes—Formation of, how effected—Oxygenation ſuppoſed to retard the Deſtruction of—Means of promoting the Increaſe of—Cauſes which render it too light for grain Crops.

THE particles of the various ſolid, as well as leſs compact, bodies that are met with in nature, and which have been rubbed down and reduced by the ſucceſſive operations of the atmoſphere, and the agency of other natural cauſes, being mixed and blended together in different ways and proportions, conſtitute the earthy compounds, which, from their being capable of abſorbing, and in ſome meaſure retaining, moiſture, as well as giving ſtability, afford the means of ſupport to various products of the vegetable kind, and form the baſes of ſoils in general; while the materials proceeding from the decompoſition and decay of numerous organized animal and vegetable ſubſtances, uniting with ſuch compounds, compoſe the ſuperficial layers of rich mould, from which plants chiefly draw or derive their nouriſhment and ſupport.

Soils being formed in this manner, it is evident they muſt vary much, both in the qualities and proportions of the ingredients of which they are compoſed. In one ſituation or diſtrict one ſort of material is abundant, and conſequently enters largely into the ſoil; in others it is deficient, while thoſe of other kinds are plentiful, and conſtitute the principal parts of the ſoils where they are found. Some ſituations too abound much more with animal and vegetable matters than others, which produce great diverſity in regard to the ſoils. The harder and more firm ſubſtances of nature, being, on account of their ſtructure, reduced more ſlowly, and with greater difficulty, into the ſtate of earth, generally enter in much ſmaller proportions into the compoſition of ſoils, than thoſe which are of a ſoft and pliable diſpoſition, and which approach nearer to the quality of earth. Thus argillaceous, loamy, and vegetable matters are found to predominate very much in ſoils in their primitive ſtate, and, according to their particular qualities and proportions, to conſtitute very material differences in their properties. Calcareous and ſiliceous earthy matters are diſtributed over ſome

diſtricts in great abundance, while in others they enter into the compoſition of the ſoils in much ſmaller proportions, and thus contribute to vary their textures and qualities.

Soils likewiſe undergo much change and alteration from other matters of different kinds, being either naturally or artificially blended and incorporated with them, and from the proportions in which ſuch mixture takes place.

There are probably few, if any, ſubſtances in nature, which, after they have been ſufficiently acted upon, and reduced by the atmoſphere and other cauſes, but which are capable of affording ſupport to ſome ſort of vegetable or other; though there is conſiderable difference in this reſpect among different earthy matters, ſome being able to ſuſtain a great number of different plants in a vigorous ſtate of growth, almoſt immediately after they become mixed with the ſoil, while others require to be applied and united for a great length of time before they afford ſuſtenance to any kind of vegetable whatever, and even then only yield a ſcanty ſupply of nouriſhment, and that for the ſupport of a few particular ſorts of plants. Where the former ſorts of materials are abundant, the ſoils are generally fertile and productive; but where the latter prevail, they are moſtly ſterile and unfriendly to vegetation*.

Soils are affected by other cauſes: beſides poſſeſſing the proper earthy matters, they muſt be embued with other principles, ſuch as the aqueous and carbonaceous, and have ſuch a conſiſtence and texture, as will properly ſupport the plants, as well as ſuch proportions of the ſeveral materials as will admit of their being retained, and applied in ſuch quantities as are ſuitable for the purpoſes of vegetation according to the differences of climate in reſpect to moiſture, and the varieties of ſituation in regard to the lands, in order to be rich, fruitful, and productive.

The ſubſtances, ſo far as they are yet known, that have a tendency to leſſen the fertility of ſoils, are the oxyds or calces of particular metals, ſome coaly and pyritical matters, acids, and certain heathy vegetable ſubſtances. But ſome of theſe ſubſtances, though unfriendly to the growth of vegetables when in theſe circumſtances, on being blended and united with other materials that enter into the compoſition of ſoils, operate upon them in ſuch a manner as to render them more fertile than they would have been without them. Mixtures and impregnations of this nature are conſtantly taking place in ſoils, which cannot be eaſily comprehended or aſcertained, but which produce great and important effects and changes in them. From this cauſe, ſoils, which are apparently ſimilar in every reſpect, on being brought into

* See Anderſon's Recreations in Agriculture, &c. vol. I.

cultivation, frequently turn out to be eſſentially different. Hence, too, originate many of thoſe facts and concluſions that appear ſo oppoſite and contradictory in the ſcience of agriculture; it is on theſe principles, likewiſe, that ſoils are capable of producing certain kinds of plants in great abundance and perfection, while others cannot by any means be raiſed upon them. It is well known to moſt perſons converſant with practical agriculture, that ſoils in which calcareous matter is predominant, even when they are grown ſo poor and exhauſted as to be almoſt incapable of producing any of the other crops commonly cultivated on them, will bear large and repeated crops of one ſort of vegetable, that of ſainfoin; and that other ſoils which are capable of affording the common crops in an abundant manner, cannot be made to produce this. In the ſame way, ſuch calcareous ſoils as have been cultivated for a great length of time, and are conſequently much impregnated with manure, afford plentiful crops of barley; while oat crops, if attempted to be raiſed upon them in ſuch a ſituation, are weak, puny, and relatively extremely ſmall. And, on the contrary, ſome primitive ſoils, not originally containing any calcareous materials, and which, not having been cultivated, cannot be impregnated with manures on firſt being broken up, often yield aſtoniſhing crops of oats, while barley can ſcarcely be raiſed at all upon them. There are many facts of a ſimilar nature ſcattered through the writings on huſbandry, but theſe are ſufficient to ſhew the great influence that very ſlight impregnations of different matters have in varying the properties of ſoils, and in rendering them more ſuitable for the production of one ſort of crop than another, while no perceptible external differences are exhibited, by which the ableſt agriculturiſt can be led to decide with certainty reſpecting their qualities.

In addition to theſe cauſes of diverſity in ſoils, there are others that ariſe from their variations in reſpect to depth, and the quality of the ſub-ſoils on which they are placed. It is a fact well known by practical farmers, and which the experience of every day confirms, that even the ſoils that are conſtituted of the moſt ſuitable ſubſtances for the purpoſes of vegetation, when only a few inches in depth, and depoſited upon beds of cold wet clay, rock, or chalk, are by no means ſo fruitful and productive as thoſe which are thicker, though of inferior quality, but reſting on a bottom which is more dry and gravelly. The difference of weight and tenacity in the under ſtrata of ſoils, likewiſe introduces great variety in regard to their powers and capabilities of rearing vegetable productions.

In a ſubject where there is ſuch great diverſity, originating from ſuch

minute circumſtances, and almoſt imperceptible cauſes, as is the caſe in reſpect to the nature of ſoils, it is extremely difficult to point out any rules or marks by which they may invariably be aſcertained. Several methods have been propoſed by agricultural writers for the accompliſhment of this highly neceſſary and important point. The mode by chemical analyſis is unqueſtionably the moſt certain and exact, but it requires, for the moſt part, more knowledge and dexterity than is commonly poſſeſſed by the mere practical farmer, and in many caſes is tedious and expenſive. It can, therefore, be only well executed by thoſe who are converſant with the ſcience of chemiſtry, and to whom expence is no material object. The natural appearance of a ſoil may, in certain inſtances, afford the means of aſcertaining its quality; but as few perſons are ſufficiently acquainted with the vaſt varieties of ſoils which occur in nature, it is a method that muſt obviouſly be extremely uncertain and confined, and which on many accounts is open to great objection.

There is another means of deciding in reſpect to ſoils, which, in many caſes, when properly limited and exerciſed, by a perſon of ſound judgment and duly experienced, is certainly not a bad one, though in ſome reſpects alſo defective: it is that of determining from the nature of the plants that are produced, and the degrees of their growth and luxuriance. Thus, where plants that are only accuſtomed to grow in good or peculiar ſorts of ſoil, are met with in their natural and flouriſhing ſtates in other places, the ſoils may be concluded to be of this or that kind, according to the circumſtances in which they are found. In this way the common nettle and the ruſh may characteriſe different deſcriptions of ſoil; the former being found to grow the moſt luxuriantly on the dry loamy ſoils, while the latter delights in the wet cold clayey ones. The growth of certain ſorts of timber trees and hedges, may alſo, in various inſtances, ſerve to direct the judgment, and likewiſe the appearances or colours of the mould in particular inſtances; thus, hazel brown denotes a good ſort of loamy ſoil, and reddiſh ſandy earth, a favourable one of the lighter kind. Too few obſervations have, however, yet been recorded by practical writers, concerning the diſtinctions afforded by the growth of different plants on different ſoils, to render it a method of extenſive utility and application. Until farther attempts be made, therefore, in this or ſome other way, and a more full and ample collection of facts be brought forward, the ſafeſt and moſt advantageous plan will, probably, be to reſt upon the baſis of experience, by which, from the combination of various little circumſtances, the agricultor may, in moſt caſes, be led to a ſafe deciſion.

The ſoils of this country have been deſcribed under numerous heads, and diſtinguiſhed by an uſeleſs variety of vague local terms. They ſeem, however, to be capable of being conſidered and characteriſed, as far at leaſt as is neceſſary for practical purpoſes, under the diſtinctions of

Clayey, *Chalky*, *Peaty or Moſſy*, and
Loamy, *Sandy*, *Gravelly*, *Vegetable Earthy ſoils.*

Each of theſe diviſions muſt of courſe comprehend ſeveral varieties, according to the nature and preponderancy of the different ſorts of materials of which they are conſtituted or compoſed.

CLAYEY SOILS.

Soils of this kind differ very materially, according to the nature and quantity of the clay that enters into their compoſitions, and the adulteration which has been produced in it by the intermixture of different earthy matters, as well as various mineral, vegetable, and animal ſubſtances. For clays are, in general, far from being pure in the ſtates in which they are found in the earth. They are in many inſtances united with large proportions of ſiliceous or ſandy matter. On theſe accounts it is that the clayey ſoils of ſome diſtricts are ſo abundantly fruitful and productive, while thoſe of others are inſuperably ſterile and refractory. Farmers, or thoſe engaged in cultivating land, for the moſt part being only acquainted or converſant with earth or mould, as it offers itſelf to their attention in the groſs or whole, have not been led to remark the aſtoniſhing diverſity that takes place in reſpect to the properties of clays, and other bodies that are united with them, as primitive and conſtituent parts of ſoils, in their original and native ſtates; but having found that they all agreed in poſſeſſing the property of imbibing and retaining moiſture, and thereby becoming ſoft and ductile, have, probably too haſtily, concluded them to have, in ſome meaſure, a ſimilarity in their other qualities. In this way erroneous notions have frequently been engendered reſpecting ſoils in which theſe ſubſtances abound. For it is well aſcertained from the uſe of clays in ſtates of greater purity, that there are very eſſential differences in their qualities. There are ſome ſorts, as that which is denominated fullers-earth, and ſeveral of the ſofter boles, that have the coheſive property in but a very ſlight degree; while others, ſuch as thoſe which are termed *tills*, are ſo extremely tenacious and viſcid, as to be capable of being drawn out into threads. And there are ſtill others which, from their ſoftneſs and property of imbibing water readily, are capable of being cut with great facility by any ſharp inſtrument; while ſome other ſorts are ſo

firm, hard, and compact, as ſcarcely to admit of being ſoftened by means of water. The clays which are employed for making the fineſt porcelain, and thoſe uſed in the compoſition of the more coarſe wares, are only to be met with in particular ſituations and diſtricts*.

Theſe facts not only ſhew that there is a prodigious variety in reſpect to the qualities of theſe ſubſtances, but that they muſt afford equal variety to the ſoils into which they enter, and therefore require to be more cloſely examined and more nicely aſcertained than they appear yet to have been, before *all* the varieties of ſoil uſually claſſed under the denomination of clayey can be well aſcertained and underſtood.

But theſe ſubſtances do not differ only in their properties and qualities, but likewiſe in their colours, and the cloſeneſs with which their particles are united. They are found in their natural ſtates of various colours, ſuch as red, white, blue, and yellow, and of different degrees of denſity, ſo as, in ſome inſtances, to readily admit of being united with the different materials that are applied, in order to ameliorate their conditions; in others they can ſcarcely be made to join with them by any means in the power of the agriculturiſt. In ſoils of the firſt kind, the quantity of ſiliceous or ſandy matter, in general, bears a much larger proportion to that of the argillaceous or clayey, than in thoſe of the latter, and in many caſes too the mixture of other ſubſtances is proportionably larger. The nature of the clayey ſtratum, in reſpect to its thickneſs or thinneſs, as well as its contiguity or remoteneſs from ſprings of water underneath it, is too commonly overlooked in conſidering theſe ſorts of ſoils; but all theſe circumſtances demand particular attention, and ought to have conſiderable influence in directing the means of cultivating and improving clayey ſoils.

It is obvious, from what has been already advanced, that, notwithſtanding the differences that take place from the accidental mixture of different materials, in different degrees and proportions, all the deſcriptions of this ſort of ſoils muſt poſſeſs more or leſs of the heavy and adheſive ſtiff qualities; and that according as theſe are more or leſs predominant, due reſpect being at the ſame time had to the various other circumſtances that have been ſtated, the buſineſs of cultivation and improvement muſt be varied and applied. In general they will require greater ſtrength, and more labour and exertion, to bring them to that ſtate of pulverization and fineneſs, which is the moſt ſuitable for the various intentions of huſbandry, than may be requiſite in many other kinds of ſoils. Beſides this, as they are frequently defective in the proper ingredients for the ſup-

* See Anderſon's Recreations in Agriculture, vol. I.

port of vegetation, and faulty in their texture, as well as combined with principles which are neceſſary to be corrected; the applications of ameliorating ſubſtances ſhould conſtantly be conducted with theſe, as well as other views. Chemical analyſis has now ſhewn, in the moſt fully and ſatisfactory manner, and the fact has been confirmed by the general experience of practical farmers, that ſubſtances of the calcareous kind are the moſt advantageous in improving and bettering the condition of all clayey ſoils. Where the deficiency is in the texture, and the want of the calcareous ingredient, lime-ſtone gravel and calcareous marles are the moſt uſeful and proper. If, however, theſe ſubſtances cannot be procured, a mixture of the coarſer kinds of ſand with perfectly effete or extinguiſhed lime may be employed; and even chalk, ſand, or lime-ſtone, in the ſtate of coarſe powder. Coal aſhes, clay which has undergone the heat of the fire, and ſmall pebbly gravel, are alſo ſometimes uſeful. Lime alone may frequently be made uſe of with great and permanent benefit; though it is thought by ſome that it is leſs proper, from its tendency to cake, and its not opening and uniting ſufficiently with the ſoils*.

But where, as well as theſe, there is likewiſe a want of vegetable matter, mixtures of calcareous marle or lime, and farm-yard dung, and ſuch compoſts as are formed by combining lime or chalk with light ſandy or gravelly earths; or lime and chalk incorporated with ſea-weeds and ſea-ſand, where they can be ſufficiently procured; would likewiſe be highly uſeful applications in theſe circumſtances. Peat aſhes are, in ſome places, uſed with ſucceſs; and gypſum, when mixed in a ſmall proportion with any of theſe vegetable products, would, probably, be found highly efficacious in this condition of clayey ſoils, where they are tolerably dry. This ſubſtance, as well as lime and chalk, may alſo be beneficially employed on ſoils of this nature that abound with acidity, in order to neutralize, and thereby correct the injurious properties of ſuch principles.

Moſt of theſe modes of improving clayey ſoils are practiſed with ſucceſs in one part or other of the kingdom. In Scotland, where lime is probably more employed on clayey ſoils, eſpecially thoſe of the better cultivated ſorts, than in England, they commonly apply dung the ſame ſeaſon that the ground is limed, but not in combination with it; by this method the lime is ſuppoſed to operate more powerfully, and with much greater expedition, than when uſed in the way of compoſt. Chemiſtry has ſufficiently demonſtrated, that lime in its active ſtate has great effect in promoting the ſolution of vegetable ſubſtances, and conſe-

* Kirwan's Eſſay on Manures.

quently of greatly augmenting the quantity of that kind of matter in ſoils. In this manner the quickneſs of its effects may be eaſily accounted for where, in ſuch caſes as that juſt ſtated, a large maſs of vegetable materials is immediately placed in contact with it. It appears, however, probable, that where theſe matters are employed in this way, the beneficial effects expected from them will not be ſo permanent or durable.

Theſe means of improving the condition of different ſorts of clayey ſoils may be greatly augmented, and aſſiſted by a judicious and well-conducted ſyſtem of tillage. The ploughings and harrowings on theſe ſoils, eſpecially where they are very tenacious and ſtubborn, ſhould be more frequently repeated; and at ſuch ſeaſons of the year as they are not too dry and cloddy, or too wet and pouchy, in order that they may be well broken down, and ſufficiently expoſed to the operation of the atmoſphere, and thus acquire a conſiderable degree of fineneſs, by which the growth of plants is much promoted. When the ſeed is put in, the harrowing ſhould be performed in ſuch a manner as to cover it very perfectly. The depth of ploughing on ſuch ſoils muſt be regulated by the circumſtances of the caſe, and the particular ſituation of the ground. Where they are thin and have a gravelly ſubſoil, and are liable to be injured by their proximity to ſprings of water, it ſhould not be ſo deep as where they have a better ſtaple, and are leſs in danger from water below them.

As moſt of the ſoils of this claſs, from the nature of their conſtituent principles, muſt be more retentive of moiſture than thoſe of ſeveral other kinds, it is highly neceſſary, eſpecially in the winter ſeaſon, that every method be taken to keep them as dry as poſſible. This is not leſs requiſite in reſpect to the lands that are in the ſtate of paſture, than thoſe that are under an arable ſyſtem of huſbandry, as the ſtagnation of much water is equally injurious whether the crops be corn, roots, or graſs. Beſides, where ſuch ſoils are in a ſtate of aration, by proper attention to ſuch means, they may at a more early period in the ſpring be in a better and more fit condition for the plough, and the reception of the ſeed, by which the danger of the crop, of whatever kind it may be, being inconvenienced by too much wet or dry weather, will, in a great degree, be avoided; as when this ſort of ſoil has once been well broken down and reduced by the different operations of harrowing and rolling, and the ſeed put in, it ſeldom ſuſtains any injury from the dryneſs of the ſeaſon afterwards*.

In the tillage of ſoils of this deſcription, from their ſtiff nature, it will likewiſe

* Donaldſon's Modern Agriculture, vol. I. p. 161.

always be neceſſary to have the implements that are made uſe of, of more ſtrength than in other caſes, and to have the animals that are employed in drawing them ſo attached as that they may do as little injury as poſſible by their treading. On this account, in ploughing ſuch lands it may be moſt adviſable to have recourſe to ſuch kinds of ploughs as admit of the horſes drawing ſingly, and following each other in the bottom of the furrows*.

In the fallowing of clayey ſoils, it is alſo neceſſary for the farmer to attend to the particular ſtate of the ſeaſon, and not break up or ſtir them when they are very dry or very moiſt, as in either caſe he muſt obviouſly perform the buſineſs to great diſadvantage; but to chooſe, as much as poſſible, proper regard being had to the nature of the crop that is to be put in, ſuch times as that the ground is neither too dry and hard, ſo as to be ſtirred with great labour and difficulty, or too much impregnated with moiſture, ſo as to render it very adheſive and poachy.

In aſcertaining the nature and goodneſs of clayey ſoils, much aſſiſtance may frequently be derived from an attention to the aſpect of the different ſorts of trees, and the appearances of the various crops; as where particular kinds of trees, ſuch as the oak and elm, and hedge plants of various kinds, are in a ſtate of luxuriant growth, and where the grain and other vegetable crops, as well as the graſs lands, are in a healthy, vigorous, and flouriſhing condition, favourable concluſions may be made; but where the former have a ſtunted, unhealthy appearance, and do not grow with vigour, and the latter are thin and ſhort, they may be decided to be poor and unfriendly for the purpoſes of vegetation†.

LOAMY SOILS.

Soils of this deſcription, as characteriſed by agricultural writers, are, probably, much too numerous; yet, from their being compounded of very different ſorts of materials, they, undoubtedly, admit of conſiderable variety. The ſubſtances that are moſt commonly found to contribute to the formation of loamy ſoils, are clay, ſand, gravel, and chalk. Sometimes an oxyd or calx of iron is alſo found blended with them in a ſmall proportion. In proportion as the argillaceous or clayey principle diminiſhes, they recede from the nature of the clayey ſoils; conſequently the nearer the quantity of that ſubſtance

* The ſwing-plough anſwers very well for this purpoſe.

† Banniſter's Synopſis of Huſbandry, p. 2.

approaches to that of the others, the ſtronger and more heavy will the loamy ſoil be. The differences in the lightneſs and friability of the ſoils of this claſs, in a great meaſure, depend on the relative proportions of the other ingredients. Where the calcareous ingredient greatly exceeds thoſe of the ſandy or gravelly kinds, they are neither ſo light nor ſo pulverizable as where they are nearly equal, or where the ſandy or gravelly matters conſiderably predominate over it. In the latter caſe, indeed, ſuch ſoils are formed as have been denominated by practical farmers *light and hungry*, eſpecially where the earthy bed or ſtratum thus produced, is but of little depth, and reſts on a gravelly or flinty bottom or ſubſoil.

The variety in the colours of ſoils of the loamy kind, ſeems, in ſome inſtances, to be produced by the union or mixture of metallic ſubſtances in greater or leſs proportions, and in more cloſe or more lax ſtates of combination with them; in others, by the prevalence of acid impregnations. The colour in the firſt caſe is for the moſt part reddiſh, approaching to brown; in the latter it is commonly blueiſh, changing by heat to a ſlight red. But theſe are not the only cauſes that influence the colour of theſe ſoils; they are much altered in their appearances, as well as other qualities, by the different proportions of vegetable or animal matter which they contain, and the different ſtates of decompoſition and decay to which they have been carried by length of time, cultivation, and other means.

In ſituations where this ſort of ſoil has been but little diſturbed, and conſequently little changed by the artificial additions of either animal or vegetable ſubſtances, and thoſe which it naturally contained not having advanced to the ſtage of perfect ſolution and decay, it is generally found of a light brown or hazel colour; but where much culture has been employed for a length of time, and large applications of animal and vegetable matters frequently made, the natural and artificial materials of theſe kinds having proceeded more nearly to the ſtate of perfect reſolution and deſtruction, it has an appearance that approaches to that of black. From theſe various circumſtances the properties of the ſoils are likewiſe conſiderably altered and affected, as well as their colours changed.

This ſort of ſoil being leſs cloſe, compact, and adheſive, than the clayey, admits much more readily of amelioration and improvement. The more ſtiff and heavy kinds, in which the argillaceous and calcareous principles are the moſt abundant, and where the carbonaceous or vegetable principle is frequently deficient, the moſt appropriate and ſuitable means of rendering them

fertile and productive would ſeem to be the application of lime in the way of compoſt or combination, with different vegetable and animal materials, ſuch as farm-yard dung, blood, ground bones, and ſimilar matters, and ſuch earthy ſubſtances as contain large proportions of ſand and gravel in different degrees of tenuity or fineneſs. The quantities in which they are to be applied muſt be determined by the particular circumſtances and the ſituation or ſtate of the grounds. In general, however, theſe ſoils do not ſtand in need of ſo much of any ſort of manure as thoſe of the clayey kinds. Lime may ſometimes be uſed alone, as where the land abounds with vegetable matters, and the calcareous principle is in too ſmall proportion, and where there is a prevalency of acidity or ſourneſs in the ſoil, which is not unfrequently the caſe where it approaches the nature of clay. But in thoſe ſoils of this nature, in which the calcareous and ſandy or gravelly ingredients enter in ſufficient proportions, good rotten dung, the vegetable matter produced from the decay of plants, and obtained by depoſition from ſtagnant water in ponds and other places, with ſeveral ſimilar ſubſtances, may be uſed with the moſt ſucceſs; and where thoſe bodies are too predominant, or in an over-proportion, ſo as to render the ſoils over-light, a portion of clayey loam may be united with ſuch ſubſtances with great advantage.

The loamy ſoils which are met with in extenſive diſtricts on the banks or borders of the ſea, and of large rivers communicating with it, are generally ſo well conſtituted and ſo fertile, as to demand little improvement from manures. The principles which moſtly abound in them are a fine ſort of ſand, calcareous matter in a high ſtate of tenuity from the attrition or rubbing down of different kinds of ſhells and other marine productions, and a rich matter proceeding from the diſſolution of various luxuriant ſea plants, and innumerable ſorts of animal exuviæ. Theſe alluvial materials are all gradually depoſited and incorporated with the natural loamy earth of the regions or places in which they are found, and thus conſtitute ſoils of the moſt fertile and productive kinds.

From the ſoils of the loamy claſs being more friable and brittle, as well as more dry, than moſt of the clayey ones, they are capable of being tilled with much greater eaſe and facility, as well as much leſs ſtrength of team, and at almoſt every ſeaſon of the year. And, on account of their property of receiving and tranſmitting moiſture more freely, they are leſs apt to be indurated by too much dry, or chilled by too much wet weather. Beſides, they are more influenced on expoſure to the agency of the atmoſphere and other external cauſes, and thereby more adapted for the promotion and ſupport of vegetation. And as they are found in moſt caſes to be leſs diſpoſed to the production of weeds,

particularly thoſe of the more injurious kinds, they can of courſe be kept clean with much leſs labour, and without the expenſive ſyſtem of management which is requiſite on many other kinds of ſoil.

CHALKY SOILS.

Soils of the chalky or calcareous kind occupy very extenſive tracts of land in different parts of the kingdom, and are marked with conſiderable diverſity, as proceeding from the nature, properties, and proportions of the calcareous matter as it exiſts in them; the ſubſtances that are mixed and combined with it; the depth and qualities of the earthy ſtratum which is placed upon it; and the diſpoſition of the ſub-ſoil or baſis on which this is formed and depoſited.

Calcareous matter is contained in many different ſtony ſubſtances, beſides that of chalk, as marble, lime-ſtone, coral, and ſhells of different kinds; and in ſtates of union with other materials, ſuch as ſand, the different ſimple earthy bodies, in different proportions, and in ſome inſtances with iron and magneſia. Its capability or powers of imbibing and retaining moiſture is conſiderable, though not ſo great as that of clay. It burns to lime by proper degrees of heat, and abſorbs carbonic acid gas or fixed air in different proportions from the atmoſphere, and returns again to the ſtate of chalk or effete calcareous matter. It is found of very different degrees of hardneſs and friability, as well as of different ſtates of fineneſs or pulverization, in different ſoils of the claſs to which it belongs. It varies alſo greatly in its effects in reſpect to vegetation; from the different matters that may happen to be combined with it in its primitive or original ſtate. It has long been known to the practical agriculturiſt, that ſome ſorts of lime may be employed in large proportions; while others cannot be uſed, except in very ſmall quantities, without doing very conſiderable injury to the ſoil with which they are incorporated. The long unexplored cauſe of this diverſity of effect in different limes, ſeems lately to have been placed in a more clear and ſatisfactory point of view, by the experimental attempts of an ingenious philoſopher*. He has found by repeated experiments, that that ſort of lime which is the moſt friendly to vegetation conſiſts entirely of calcareous earth, and quickly abſorbs a large portion of carbonic acid gas or fixed air from the atmoſphere; while that which is

* Tennant on the different ſorts of lime uſed in agriculture, in Tranſactions of the Royal Society, 1799, Part II.

injurious and unfriendly to the growth of plants contains only three parts of pure calcareous earth, the other two conſiſting of magneſia, and that it abſorbs comparatively but an extremely ſmall portion of carbonic acid gas or fixed air from the ſurrounding atmoſphere. This kind or mixture of calcareous matter was alſo aſcertained to be very ſlow in acquiring the power of ſupporting vegetation, even after it had been converted into lime, and remained for a conſiderable length of time in the ſtate of mortar. The lime-ſtone in which there is a mixture of magneſia, is much harder, and diſſolves conſiderably more ſlowly in acids than that which is purely calcareous. The ſame author likewiſe ſuppoſes that the cryſtallized ſtructure commonly obſerved in the magneſian lime-ſtone indicates that it has not been formed by the accidental conjunction of the two earths, but conſtituted by their chemical union. The difficulty with which it is diſſolved by means of acids, may alſo, he thinks, in ſome meaſure, depend on the attraction of its different component particles to each other.

This ſort of lime-ſtone would ſeem to abound in different parts of the kingdom. It is obſerved to extend for thirty or forty miles from a little to the ſouth-weſt of Workſop, in the county of Nottingham, nearly to Ferry-bridge in Yorkſhire. In the account of the agriculture of the midland counties, Mr. Marſhall obſerves that the lime made at Bredon, in Derbyſhire, is hurtful to vegetation, when employed in large proportions; and our experimenter has found that it contains magneſia nearly in the quantity ſtated above; but that the ſtone in this inſtance is frequently cryſtallized in a rhomboidal form, and petrified ſhells, not calcareous, but ſimilar to the compoſition of the ſtone itſelf, are occaſionally, though ſeldom, found in it. The different combinations of calcareous matters are ſometimes found contiguous to each other. At Matlock, in Derbyſhire, it is ſtated that the rocks on the ſide of the river where the houſes are built are magneſian, while thoſe on the other are calcareous; and that the magneſian rock appears to be incumbent on the calcareous ſtratum, as in deſcending a cave formed in this rock, a diſtinct vein of common lime-ſtone may be ſeen which contains no magneſia. The calcareous ſtratum is very full of ſhells, and there are alſo ſome in the magneſian rock, but they are extremely rare. The practical diſtinctions of hot and mild limes, which have frequently been made by thoſe engaged in the improvement of ſoils, and which have been particularly attended to by a late writer *, prove that the magneſian calcareous matter is met with in the more northern counties: that which is conſidered as

* Fenwick's Eſſay on Calcareous Manures.

hot being alſo found by him to be more difficult of ſolution in acids. Theſe important and intereſting facts not only ſhew that whatever fameneſs there may be in the nature of calcareous matter when in its pure and unadulterated ſtate, that as met with in ſoils, and different ſubſtances of the calcareous kinds, it has conſiderable diverſity, and when in union with magneſia it is in a high degree prejudicial to the growth of vegetables.

Calcareous matter, whether it be in the effete or ſtate of *carbonat*, or in the more active one of cauſticity, as quick-lime, ſeems ultimately to promote the reſolution and deſtruction of vegetable and animal ſubſtances; in the latter ſtate, however, it acts with much greater violence on theſe materials, deſtroying their organization, and diſſipating their principles more quickly, as well as robbing them more completely of the carbonic acid gas or fixed air, which is ſo eſſential; while in the former it operates with great mildneſs, and only aids the reſolution of thoſe ſubſtances by gently promoting the proceſs of putrefaction.

The proportions of clayey, loamy, and gravelly ingredients, which are conjoined with the calcareous matters of theſe ſoils, are various in different diſtricts; where the argillaceous and loamy materials are comparatively in large quantities, ſoils of the heavier chalky kinds are formed, and where the ſandy or gravelly are predominant, we have the lighter ones. There are alſo material differences proceeding from the earthy matter with which the calcareous ingredient is mixed in the ſtate of ſoil. Where the quantity of this is ſmall, and not reduced into any very perfect ſtate of mould, the ſoil, as is evident, muſt be poor and thin; but where the depth of this ſuperficial ſtratum is conſiderable, and the animal, vegetable, and other ſubſtances, of which it is compoſed, is advanced to a more complete ſtage of decompoſition and decay, the ſoils are more rich and heavy. Some variety is likewiſe cauſed by the ſtate of the under-ſtratum or ſubſoil. If it be compact and much intermixed with ſiliceous or flinty matter, or have a mortary hardneſs, it is leſs favourable than where it is of a more open, brittle, or powdery texture.

From what has been ſtated, the means of improving chalky or calcareous ſoils muſt be evident. As the calcareous principle is here abundant, the principal intention is the alteration of their textures, and the ſupplying of vegetable matter. This is effected in the heavier ſorts of chalky ſoils, by the application of clayey and ſandy loams, according to the particular circumſtances of the caſes; and in the thinner or more light lime-ſtone ſoils, it may be accompliſhed by means of clay, argillaceous marle, and the rich imperfectly decompoſed vegetable matter

ariſing from the depoſition and accumulation of ſuch ſubſtances in low, cloſe, and wet ſituations.

Farm-yard dung, and compoſts of all kinds of dung, with good mould, will be advantageous. Soot and malt-duſt have, likewiſe, in different inſtances, been ſucceſsfully employed.

Where miſchief has been experienced from the too great abundance and prevalence of magneſian lime, or calcareous matter, the plentiful uſe of aſhes produced from the combuſtion of freſh vegetable ſubſtances, would ſeem to be the moſt ſuitable application as a remedy.

Whatever appearances of lightneſs there may be in chalky ſoils, they require conſiderable ſtrength in the team, where the ſtaple or earthy ſtratum of the lands will admit of their being wrought to a tolerable depth; but where there is a thinner ſurface of earthy materials, leſs force of draught will be requiſite. In the latter caſes, the ſoil is, however, far more precarious and uncertain, as well as much leſs productive in reſpect to the crops that are cultivated upon it, than in the former. As chalky ſoils are not ſo liable to be injured by water as others, the buſineſs of tillage is much leſs impeded from that cauſe; but a dry ſeaſon ſometimes renders them ſo hard as to be totally incapable of being broken up, until they have been moiſtened by the falling of a conſiderable quantity of rain. From the great wear, by friction and other cauſes, that takes place in the ploughing and breaking up of moſt ſoils of this claſs, the ſtate of the irons of the ploughs, or ſuch other inſtruments as are employed, muſt be more frequently and more particularly attended to, as from the neglect of this circumſtance much inconvenience, as well as loſs, may ariſe to the farmer.

SANDY SOILS.

Sands ſeem to have been gradually formed by the attrition and rubbing down of the various ſolid ſubſtances that are found in nature, eſpecially ſuch as are of the ſiliceous, calcareous, and ſtony kinds, and are of different degrees of fineneſs as they approach the ſize of gravel. They are alſo met with of various colours and appearances in different regions or tracts of country, ſuch as white, duſky brown, yellow, and red. Theſe differences, as well as thoſe which reſpect their weight, tenacity, and other properties, depend on the nature and proportions in which many other ſorts of materials enter into combination with them.

Where the proportions of clayey, loamy, or other earthy ſubſtances with which they are mixed, approach nearly to that of the ſand, the heavier ſorts of ſandy ſoils are formed; but where theſe enter only in very ſmall quantities, we have the light ſandy ſoils; and where they are hardly met with at all, the ſoil is a looſe blowing ſand, moſt commonly of a white or browniſh appearance. The portions of vegetable matters that are intermixed with different ſoils of the ſandy kind are not leſs various than thoſe of the clayey and loamy, from which conſiderable differences of quality are produced. Theſe differences in their textures and compoſitions, alſo introduce others which reſpect their powers of admitting and retaining heat and moiſture. The openneſs and want of adherence in ſuch ſoils, while they allow of the admiſſion of heat and water more readily, permit them to be carried off with greater eaſe and expedition, they are therefore leſs permanently benefited by their influence than many of the cloſer and more adheſive ſoils.

From this view of the conſtituent principles of ſandy ſoils, it is obvious that they are chiefly deficient in the calcareous, argillaceous, loamy, and vegetable ingredients. The intention of the agriculturiſt ſhould, therefore, for the moſt part be directed to the augmentation of their cohefive property, and the ſupply of the calcareous and decayed animal and vegetable matters. With a view to the firſt, argillaceous and loamy materials may be had recourſe to; and it has been obſerved by an able and intelligent writer*, that a leſs proportion of clay is required in the improvement of light ſandy ſoils, than of ſand in clayey ones; but whether this rule be generally correct or not, ſome of the thinner and poorer ſorts of ſandy ſoils certainly demand large proportions of the argillaceous ingredient. Where the calcareous principle is in ſufficient abundance, argillaceous marle and clayey loams are the moſt ſuitable; but where it is deficient, calcareous marles and loams will be more advantageouſly employed. On theſe principles it is, that in the counties of Suffolk, Norfolk, York, and ſome diſtricts of Scotland, experience has ſhewn the former to be more beneficial; while in other places, as the Iſle of Wight, the diſtrict of Caermarthen in Wales, in the counties of Suſſex, Cheſter, and Stafford, in England, and the northern parts of Scotland, the latter has been found to produce the moſt advantageous effects on ſandy ſoils.

The defect of vegetable matter in theſe ſoils may be remedied by the uſe of farm-yard and other compoſts, proceeding from animal and vegetable ſubſtances

* Fordyce's Elements of Agriculture, p. 89.

in a ſtate of putrefaction. But good earth, or mould, and the imperfectly reſolved matter found in boggy ſituations, may alſo in many inſtances, where theſe cannot be eaſily procured, ſupply the deficiency in a very beneficial manner.

The folding of ſheep upon ſoils of this nature, likewiſe, contributes greatly to their improvement, not only by the quantity of dung and urine that is depoſited upon them, but the conſolidation and firmneſs of texture that is produced by their treading.

All theſe different ſorts of materials may be applied either alone or combined with one another in the form or ſtate of compoſts. The marles and clayey ſubſtances are, however, for the moſt part, laid on in the ſtates in which they are found; but the farm-yard dung, and peaty matter, often in mixture with each other, or with ſubſtances of other kinds, ſuch as thoſe of an earthy nature: the peaty earth may alſo frequently be uſed alone, when applied to the ſurface of paſture lands.

The light, open, and porous texture of ſandy ſoils, renders them much more eaſily cultivated and kept in order than thoſe of the ſtrong and cloſe kinds; conſequently the farms where they prevail are generally large; and when properly prepared they are better adapted for the growth of many ſorts of crops, ſuch as thoſe of the bulbous and tap rooted ſorts. They have alſo another advantage, which is that of puſhing forward the crops with more expedition. Whatever inconveniences attend them, are moſtly ſuch as proceed from the want of a ſufficient degree of coheſion among their conſtituent particles and ſolidity of texture. On theſe accounts they often counteract the beſt and moſt judicious management. The roots of the crops are liable to become naked and expoſed from ſtorms and various other cauſes; and if grain, to fall down and be lodged ſo early in the ſeaſon as to render them of little value.

GRAVELLY SOILS.

In the ſtate of gravels which contribute to the formation of this claſs of ſoils, there is a variation of ſize in the pieces or particles of which they are compoſed, from that of a very ſmall pea to the largeſt cockle. Where they become of ſtill larger dimenſions they are termed ſtones or rocks, according as they are in ſmall portions or large maſſes; and the ſoils are then ſaid to be ſtony or rocky, as the circumſtances of the different caſes may happen to be.

The beds of gravel, whether they be of the larger or ſmaller kinds, are moſtly

either of the ſiliceous or flinty nature, or of the calcareous or chalky; but the ſtones and rocks are of very different kinds. With theſe diſſimilar ſubſtances, ſome others in different ſtates of reduction and pulverization are blended and united in various proportions, ſo as to conſtitute gravelly ſoils that differ conſiderably in their textures and other properties. The chief of theſe are loams, and the mould or earthy matter formed by the deſtruction and decay of numerous animal and vegetable ſubſtances.

The gravelly mixture is ſometimes alſo found to approach nearly to the ſurface, while at others it recedes conſiderably from it*. In ſome inſtances ſprings riſe immediately underneath; in others they are at a great depth. The bottom, or ſub-ſoil, is likewiſe various; in ſome caſes it is ſtony and rocky, in others it is clayey, or a rocky gravel, and ſometimes ſand, &c.

The open porous nature of gravelly ſoils diſpoſes them to admit moiſture very readily, as well as to part with it with equal facility; from the latter of which circumſtances they are ſubject to burn, as it is termed, in dry ſeaſons, which is not the caſe in the heavier or more retentive ſort of ſoils.

The defects in the conſtitution of gravelly ſoils may be removed by the applications of one or other ſorts of marle, where they can be procured, according to the circumſtances of the caſe. Where the gravel is of the calcareous kind, clay, or clayey loam, may be moſt properly made uſe of. And a mixture of the carbonate of lime, or lime in its effete ſtate, and clay, would ſeem to admit of a pretty general application to theſe ſoils. Chalk, as being of the ſame nature, may alſo be made uſe of in the ſame way. Indeed for theſe kinds of gravel, which from their contiguity to ſprings are apt to lie wet in the winter, there is no manure more properly adapted than chalk; which, although it does not abound with vegetable matters in any large proportion, like yard dung, and ſome other dreſſings, is, however, an excellent preparative for them, and will, in ſome meaſure, ſupply the place of ſuch ſubſtances. From its abſorbent nature, it is of good effect not only to counteract the ſuperabundant moiſture of ſuch ſoils, but to leſſen their heat; by which means the diſpoſition to burn in the ſummer, ſo inimical to the growth of various crops, and to which all gravels are in ſome degree liable, is prevented; and in this laſt view chalk, though particularly

* It is obſerved by Mr. Middleton, in his excellent Report of the Agriculture of the County of Middleſex, that "when the gravel is very near to the top, a full crop of yellow-bloſſomed broom covers the ground, if in a ſtate of graſs, and when ploughed an equally full crop of ſorrel." This he remarked in the old incloſures, and on ſeveral places on Enfield-chaſe.

adapted to thoſe of the wet and ſpringy kind, may be applied with ſucceſs on gravels of almoſt every denomination *.

The deficiency of the vegetable and animal earthy matters, where it exiſts, may be properly ſupplied by dung of the farm-yard kind in its more rotten ſtate, and various animal excrements. Theſe are frequently applied to the gravelly ſoils, with the greateſt effect and advantage, in the form of compoſts, with good loamy mould, aſhes, the mucilaginous and clayey depoſitions of rivers and ponds, and other ſubſtances of a ſimilar kind. Several of theſe materials, and ſome others of the animal claſs, are, however, often uſed ſeparately to the ſurface of ſoils of this ſort.

Soils of this deſcription may alſo be much improved by a judicious variation of the green vegetable and other crops that are cultivated upon them.

Gravelly ſoils, from the lightneſs of their texture, and their not affording great reſiſtance, except where the ſtones are large, or there are rocks, are not expenſive or difficult in the means of cultivation. All the neceſſary buſineſs of this ſort is capable of being carried forward with much eaſe and expedition, and the lands are, in general, ſoon brought into the proper ſtates for the reception of crops.

PEATY OR MOSSY SOILS.

These ſoils are met with in pretty extenſive tracts in many parts of the kingdom. In ſome places, in England, they are provincially denominated moory, peaty, and heathy ſoils; in Scotland, they are more commonly known by the title of moſſy; and in Ireland, they receive the name of boggy ſoils. They differ, like all the other kinds of ſoils, from the nature of the ingredients of which they are conſtituted or compoſed, and the proportions in which theſe are found to prevail in them. Where the vegetable or peaty material predominates but little over the other ſubſtances with which it is mixed and incorporated, the lighter ſorts of peaty, moory, or heathy ſoils, are formed; but where the other matters bear only a ſlight proportion to it, the deep and heavy, peaty or moſſy, ſoils preſent themſelves. In different diſtricts the peaty matter is found of different depths, and of various degrees of denſity or cloſeneſs of texture, probably proceeding from ſome original differences in the vegetable ſubſtances from which it was formed, or the greater advances which it has made to the ſtate of perfect de-

* Banniſter's Synopſis of Huſbandry, p. 13.

compoſition or decay. The ſúb-ſoil in moſt of the deep moſſy diſtricts is of the clayey kind, more or leſs ſtiff and heavy, over which the peaty or moſſy material is depoſited, generally in a ſort of ſtratified order; the firſt layer of which being commonly not more than ten or twelve inches in thickneſs, exhibits the appearance of a richiſh brown earth, in all probability from the incorporation of the loamy or clayey matters, with the peat or vegetable earth, lying immediately upon them, and conſtituting, originally, perhaps, the ſurface of the ground. The layer that ſucceeds to this is moſtly of a dark colour, and conſiderable thickneſs, apparently formed of a great variety of vegetable or other materials in the more perfect ſtages of reſolution and decay, united together by time and other circumſtances with more or leſs compactneſs and ſolidity. The uppermoſt ſtratum, or that which is placed upon this denſe, peaty matter, is, in general, of a very pale colour, and very light ſpongy texture, ariſing poſſibly from the graſſes, leaves, and other vegetable ſubſtances, of which it is formed, not having attained that ſtate of decay which conſtitutes the darker ſorts of peaty earth.

But in the more ſuperficial peaty ſoils, little or nothing of this ſtratified appearance is met with. A coat of peaty earth, differing greatly in thickneſs according to the peculiarity of the ſituations, and other circumſtances, is formed by a great length of time from the deſtruction and decay of ſucceſſive crops of graſſes, leaves, and ſubſtances of the heathy or other kinds, and depoſited upon, and intermixed with, the various harder materials of the ſoils which happened to be underneath them. By theſe means much variety is produced in the ſoils. Where the under-ſtrata of earthy matter are tolerably good, and the crops of vegetables large and luxuriant, the better ſorts of light peaty ſoils ſeem to be predominant; but where the quality of the under-ſtrata are indifferent, and the vegetable products ſcanty, as well as feeble in their growth, and principally of the heathy tribe, the poor peaty and heathy, or moory ſoils, are met with.

All peaty ſoils ſeem to be thus gradually formed by the depoſition of vegetable matter, ſupplied by the diſſolution and decay of aquatic and other plants that grow in low moiſt ſituations, as well as ſubſtances of other kinds brought down by water, from the high grounds in their neighbourhood, in the ſtates of ſolution and diffuſion, and gradually depoſited from it on its becoming in a ſtate of ſtagnation, by means of obſtructions and ſtoppages proceeding from different cauſes.

From the nature of the compoſition of theſe ſoils, it is obvious that they muſt be very retentive of water, eſpecially where they are of any great depth; hence

they ſeldom or ever become free from the exceſſive quantities of moiſture, with which they are loaded in the rainy ſeaſons. An able author juſtly obſerves, that from the rays of the ſun and drying wind being exerted during the ſummer ſeaſon in carrying off, by means of evaporation, the ſuperabundant moiſture in ſuch caſes; and heat being known to be abſtracted from bodies, and cold generated thereby, effects muſt be produced highly injurious not only to climate but vegetation in general, and more particularly to ſuch plants as ſtand in need of a higher degree of heat, and more nouriſhment, than ſuch ſoils are capable of ſupplying.

And he thinks that there can be very little doubt but that theſe prejudicial effects on the growth of vegetables extend themſelves to the more dry lands adjoining ſuch fens or deep moſſes *.

The ſurface-ſtratum of peaty ſoils, from its being more expoſed to the influence and action of the pure air of the atmoſphere, is, it is alſo obſerved, much leſs ſoluble than the under-ſtrata, conſequently in its ſimple or unmixed ſtate leſs proper for the purpoſes of agriculture. From the ſame cauſe too, it becomes leſs capable of ſupporting flame, and is therefore improper for the purpoſes of fuel.

From what has been obſerved reſpecting the compoſition, formation, and properties, of peaty ſoils, it is evident that they muſt require different methods of management, in order to reclaim and render them fuitable for the growth of the various ſorts of vegetables that are objects of huſbandry.

In the deep moſſes, the firſt thing to be attempted is to draw off, as much as poſſible, the ſuperabundant moiſture, by the cutting of proper drains, and ſuch other means as the nature of the ſituation, and other circumſtances, will admit of. In places where water in ſufficient quantity can be conveniently made to paſs through ſuch moſſes, and where the ſoil underneath is good, much may be effected by floating away the principal part of the moſſy ſubſtance; but where the moſſes are not deep, or the ſoils under them of a good quality, after the making of proper drains, the beſt way is, probably, to ridge them in ſuch directions and modes as are the moſt effectual in promoting the exit or paſſage of the ſtagnant water which they contain. Different materials may then be applied with the intention of improving their textures, and promoting the diſſolution of the undecayed parts of the vegetable matters that are contained in them. The firſt may be accompliſhed by the application of various gravelly ſubſtances, ſand, and coarſe earth; and the latter, eſpecially where there is a large growth of heath and other

* Dundonald's Connection of Agriculture with Chemiſtry, p. 33.

coarſe plants, by the uſe of lime in its active or cauſtic ſtate: but where ſuch plants do not ſo much abound, alkaline ſubſtances, chalk, calcareous marle, the ſhelly kinds of ſea ſand, and the carbonate of lime, may be more advantageouſly had recourſe to.

Shell marle, chalky ſubſtances, rich clays, and lime-ſtone gravels, being frequently met with under deep peat moſſes, proper inveſtigation ſhould conſtantly be made by means of boring them in various parts; as in caſe any of theſe materials can be diſcovered at a ſuitable depth, ſuch grounds may be brought into cultivation much more cheaply and conveniently, from their being applied more readily to the ſoft ſpongy ſurfaces of ſuch ſoils, than where they are under the neceſſity of being carted upon them from conſiderable diſtances. Paring and burning is uſeful in both the above views, where the quantity of vegetable matters on the ſurface is conſiderable, and of the coarſe kind; but the method of applying good earthy matter is to be preferred, where it can be procured in an eaſy and not too expenſive manner.

Something may likewiſe be effected in the way of promoting the fertility of theſe ſoils by cropping with particular ſorts of vegetables. Thoſe that have large branching ſtems, and which cover the ſurface of the ground very much, thereby excluding the action of the air in a great meaſure upon it, are conſtantly to be employed as the moſt advantageous and uſeful.

VEGETABLE EARTH OR SOIL.

This kind of earthy material conſtitutes the ſuperficial bed or ſtratum, in which plants, for the moſt part, vegetate, in every ſort of ſoil; and differs very much in different places, from the variations that take place in its depth, and the greater or leſs progreſs that has been made in the ſeveral ſubſtances of which it is compoſed to the ſtage of perfect decompoſition or decay.

Some variety may, likewiſe, be cauſed by its being more intimately or more looſely mixed and blended with the other bodies that are found in ſoils. It ſeems probable, too, that the earthy matter which is formed from the deſtruction of ſome ſorts of vegetable ſubſtances may be better ſuited for the purpoſes of vegetation than that which proceeds from others.

Vegetables, from their containing a conſiderable portion of mucilaginous matter in a ſtate of mixture with their other ſubſtances, become, in ſome meaſure, capable of ſolution in water, though the external ſurfaces of living plants, on account of the reſinous and animalized materials that enter into their com-

poſition, are protected from its operation. From the former circumſtance, and that of earthy matters being contained in them, which had been taken up in the ſtate of ſolution with their freſh juices while growing, it is evident that large quantities of vegetable mould muſt be continually formed and depoſited on lands by the natural decay of ſuch ſubſtances.

But the formation of vegetable mould or earth is farther effected by means of the putrefaction or diſſolution of ſuch vegetables as are cut down, or otherwiſe deſtroyed, on the ſurface of the ground, and the application of various kinds of dung and compoſts. Where theſe have been in great abundance for a long time, there is moſtly a deep rich ſurface ſoil of this earth; but where few vegetable products, and thoſe of the leſs luxuriant kind, have been left to undergo the above proceſs, or little aſſiſtance given by means of manures, the cruſt of ſurface mould is generally thin and poor. The reſolution of vegetable matters is greatly promoted by a proper degree of moiſture and heat, as well as a ſuitable ſtate of the air.

In the proceſs of the putrefaction of theſe ſubſtances various chemical changes take place;—the water which they contain is decompoſed; there is an abſorption of the pure air of the atmoſphere; heat is diſengaged; and new combinations of the gaſſeous and ſaline kinds are formed. By theſe changes many ſubſtances are, therefore, converted to the uſe and ſupport of vegetable life, that could not have been applied by any other means; beſides, they are rendered much more extenſively applicable than they could otherwiſe have been, for that purpoſe.

The abſorption of pure air from the ſurrounding atmoſphere, or the proceſs of oxygenation, is conſidered, by a late writer, as the chief cauſe of the retention of vegetable matter on the ſurface of the earth, in deep peaty ſoils, and moſt others, but eſpecially thoſe that have been long in a ſtate of tillage. The vegetable matter by this means being rendered leſs deſtructible, ſcarcely any of it is carried away in a diſſolved ſtate by rains, or the application of water in other ways, conſequently accumulation muſt take place, which, under other circumſtances, could not have been the caſe*. The vegetable materials contained in ſoils, therefore, from their admitting different degrees of this proceſs,

* The Earl of Dundonald, in his treatiſe On the Connection of Agriculture with Chemiſtry, obſerves, that "to this proceſs of oxygenation, the continuance of vegetable matter on the ſurface of the earth is principally to be aſcribed; as in the caſe of peat moſſes, fens, and moraſſes, as well as in moſt ſoils, but more eſpecially in ſuch as have long been under cultivation. The indeſtructible ſtate of vegetable

and thereby becoming more or leſs inſoluble, poſſeſs different powers in promoting the growth and nouriſhment of plants. Where they have been expoſed to the action of the oxygenous or pure part of the air, for a conſiderable length of time, they are much more inſoluble, than where this has been the caſe for only a ſhort period.

In order, therefore, to promote the formation of vegetable earth or mould, recourſe muſt not only be had to ſuch ſubſtances as accelerate the putrefactive proceſs, but alſo ſuch as have a tendency to increaſe the ſolubility of the vegetable mould or ſoil itſelf. The firſt of theſe purpoſes may be accompliſhed by the application of ſuch materials as have been found uſeful in changing vegetable ſubſtances into the ſtate of mucilage, ſuch as the carbonate of lime, or effete lime, marle, chalk, and calcareous matters in general, and alſo ſome earthy ſaline ſubſtances, as the refuſe of ſalt manufactories, &c. The latter is to be attempted by the uſe of different alkaline ſubſtances, ſuch as the aſhes produced by the burning of various green vegetable materials, the urine of animals, the liquor of dung-hills, night-ſoil, and other animalized matters.

Vegetable mould may, likewiſe, be augmented by many other means; ſuch as the growth of thoſe kinds of crops that cover the ground much, and thereby produce a ſtagnated ſtate of the air; the conſuming upon the ground or the turning down of rich, full, and ſucculent ſorts of green crops, by which a large portion of vegetable matter is quickly brought into the ſtate of decay; and the deſtruction and evacuation of various ſorts of inſects that are prevalent in ſoils, by the application of ſubſtances of different kinds.

matters, under theſe circumſtances, and their conſtant accretion, may," he thinks, "be referred to the inſoluble compounds, produced by the action of pure air on theſe inflammable ſubſtances.

"The inſolubility, to a certain degree, of this ſyſtem, adopted by nature, is undoubtedly," ſays he, "to be preferred to one more completely ſoluble; for it is evident, that if putrefaction, or oxygenation, had poſſeſſed the power of rendering all the vegetable matter, by a ſpeedy proceſs, ſoluble in water, two pernicious conſequences muſt have followed: The rains would have waſhed down ſuch extracts, and ſoluble matters, as faſt as formed, into the rivers and ſprings, contaminating the waters, and rendering them unfit for the exiſtence of fiſhes, or for the uſe of terreſtrial animals. The ſea, in proceſs of time, would thereby receive all the vegetable and animal produce of the dry land, and the earth would ultimately become barren, conſiſting alone of the ſimple earths, without any admixture of vegetable matter; conſequently there could be no accumulation of this ſubſtance on the ſurface, as is the caſe, to an immenſe degree, at preſent. As ſuch there cannot," he conceives, "be a doubt, but that the preſent incomplete proceſs of putrefaction, oxygenation, or ſolution of organic bodies, has been eſtabliſhed by the great Creator of all things for wiſe and benevolent purpoſes; eſpecially when it ſhall be underſtood, that the apparent imperfections of this (to a certain degree) inſoluble ſyſtem are, as they reſpect agriculture and vegetation, to be remedied, when neceſſary, by the ingenuity and induſtry of man."

It is obſerved by the able author juſt mentioned, that a ſuperabundance of vegetable matter in ſoils, eſpecially where it is much expoſed to be acted upon by the oxygen or vital air of the atmoſphere, is apt to render the ground too looſe and open in its texture for the growth of moſt ſorts of grain; winter corns in particular, from the ſudden alternations of froſt and thaw, being frequently thrown out of ſuch ſoils and deſtroyed. Where this is the caſe, great benefit may be derived from the uſe of various ſaline matters, and lime in its effete ſtate, as by ſuch means the vegetable parts of the ſoil will be reduced to their proper and moſt productive ſtate*.

* Dundonald on the Connection of Agriculture with Chemiſtry, p. 175.

SECTION VII.

MANURES.

MANURES—Changes undergone in Subſtances in the Formation of—Fluid, elaſtic, and volatile Matters chiefly prepared in the Soil—Are in different Proportions according to Circumſtances—The more groſs Matters applied to Lands chiefly termed Manures—Changes neceſſary in theſe to fit them for the Support of Vegetation—Much Difference in, according as they abound with certain Subſtances or Principles—This probably the Cauſe why ſome Matters are ſo ſuperior to others when uſed equally—Other Modes in which they contribute to the Growth of Crops—Difficulty of Arrangement of—May probably be uſefully divided into Animal, Vegetable, Foſſil, Saline, and Compound Manures.—MANURES FROM THE DECOMPOSITION OF ANIMAL SUBSTANCES.—How they contribute to the Support of Plants—Differences in the conſtituent Principles of, may produce Differences in the Effects of—Their Tendency to Putrefaction—How promoted—Circumſtances to be attended to in.—Hard animal Subſtances.—Different Natures of—Bones, Horns, Hoofs—Circumſtances to be attended to in their Preparation, Mixture, Combination, and Application.—Soft animal Subſtances—Various Kinds of—Greaves, Sugar Scum, Refuſe of Manufactories— Fiſh, Blood, &c.—Different Natures of—Circumſtances to be regarded in the Preparation of—In the Combination and Mixture of, with other Matters—In the Application and Uſe of.—Animal Dungs—Nature and Goodneſs of—On what it depends in general—Kinds of employed—Effects of, how produced—Night-ſoil—Of Birds—Of Horſes and Cows—Of Sheep—Circumſtances to be attended to in the collecting of—In the mixing of, with other Subſtances—In the Application or Uſe of, on Land.—MANURES FROM THE DECOMPOSITION OF VEGETABLE SUBSTANCES—Methods in which they are prepared for the Support of Plants—Different Matters ſuitable for, formed during the Decompoſition of—Reaſons why they differ in their Effects on Land—Subſtances that may be uſed, various—Manner in which they may be rendered uſeful—Refuſe Vegetable Subſtances—Green Crops—Sea Weeds—Tanner's Bark—Mud from various Places—Malt Duſt—Refuſe of Oil-cakes, &c.—MANURES FROM THE AGENCY AND DECOMPOSITION OF FOSSIL SUBSTANCES—Calcareous Matter in general—Lime or calcined calcareous Matters—Reaſon of the different Effects of, in different Caſes—Why it may vary, when prepared from different Subſtances—Effects of in its active State, or that of Quick-lime—In its effete State, or that of Carbonate of Lime—From its Combinations with different Subſtances—From its containing Phoſphorus.—Lime-ſtone—May be employed as a Manure without Calcination—Manner of preparing it for Uſe in this State—Different Effects of when thus applied—Soils on which moſt uſeful.—Lime-ſtone Gravel—Manner of rendering it more generally uſeful.—Chalk—Nature of—Mode of uſing it with the greateſt Chance of Succeſs—Effects of, on various Kinds of Soil—Proportions in which applied on each Kind.—Marle

*—Different Kinds of, noticed—Manner of aſcertaining them deſcribed—Agree in ſome Properties—Manner in which they ſhould be applied in different Caſes—Proportions in which they may be employed—Uſed on tillage and graſs Lands—Circumſtances to be attended to in their Application in each Caſe—Particulars to be regarded in repeating the Application of.—Sea Sand—Utility of, as a Manure—Soils on which it may be employed—Quantity of uſed—Mode of Application.—Common Sand—Nature of—How it may be uſeful on Land.—*MANURES FROM THE AGENCY AND DECOMPOSITION OF SALINE SUBSTANCES*—Different Sorts of, may be uſed—Modes in which they produce their beneficial Effects—Nature of particular Subſtances explained---Bleachers' Refuſe---Soap-boilers' Waſte---Vegetable Aſhes---Coal Aſhes---Circumſtances neceſſary to be attended to in each---Mode of employing them—Advantages reſulting from the Application of, in different Caſes.---Soot---Modes in which it may be uſeful as a Manure---Manner of applying it---Reaſons why Subſtances containing ſaline Matters ſhould be preſerved in Sheds.---Muriat of Soda, or Sea-ſalt---Utility of, as a Manure, not well aſcertained---How it may promote Putrefaction---Other Ways mentioned in which it may be uſefully employed.---*MANURES FROM THE COMBINATION OF DIFFERENT SUBSTANCES*---Farm-yard Compoſt---Nature of Subſtances from which formed—Means of promoting the Formation of---Manures may frequently be uſed with more Advantage when combined than in their ſimple States---Circumſtances neceſſary to be regarded in the mixing of---Manures much increaſed in this Way—Cautions to be regarded in uſing different Subſtances—Lime in its different States, alkaline, ſaline Matters---Quantities of ſuch Manures neceſſary to be applied to Land in different Caſes---Circumſtances that muſt be attended to in their Uſe in this Way.---*MEANS OF AUGMENTING AND PRESERVING MANURES*—Waſte of all Sorts of Subſtances to be prevented—To be reduced more quickly into the State of Manure—Attention to the Form and Conſtruction of the Farm-yard neceſſary---Form of, deſcribed—Manner of proceeding with different vegetable Matters in—By mixing of Lime with—By preventing Evaporation—By collecting different Sorts of Materials—By folding Sheep—By managing different Green Crops—By preventing the Waſte of the Soil of Privies---By Attention to the ſaving of different animal Matters---By collecting vegetable Earth---By the proper Management of Dung-hills---Various Circumſtances in reſpect to the Management of each, deſcribed.---*GENERAL APPLICATION OF MANURES*---States of, in which they may be applied with moſt Advantage---Modes of in different Caſes---To arable Lands---To graſs Lands---Seaſons in which the Application of may be beſt performed, in different Inſtances---Circumſtances reſpecting their putting into Land, deſcribed---When applied on the Surface, what neceſſary to be attended to---Means of applying them in the moſt ſaving Way---Kinds of Manure that may be uſed to moſt Advantage, in different Caſes.*

FROM the changes that are conſtantly taking place among bodies in nature, and the new combinations which are formed in conſequence of them, a great variety of matters are unfolded, elaborated, and prepared for the nouriſhment and ſupport of vegetable life.

Some of the ſubſtances which contribute in this way poſſeſs conſiderable fluidity

and volatility, ſuch as water, and various gaſſeous materials, as oxygen, hydrogen, azote, and carbonic acid, in different ſtates of combination * ; and are chiefly formed and applied in the ſoils on which the plants exiſt or grow, and in greater or leſs proportions, according to the ſeaſon of the year, the nature of the climate in regard to heat or cold, and the ſtate or ſituation of the grounds in reſpect to its qualities ; while others are more groſs and heavy, and require to be applied and incorporated with ſoils, or ſpread out upon their ſurfaces, in order that they may produce their effects in promoting vegetation. It is principally to theſe, as being the means of ſuſtaining different ſort of plants as crops, that the term *manure* has been given by practical writers on agriculture, though it is extremely obvious that they muſt undergo different changes, and be reſolved into their more elementary principles, before they can be taken up and contribute to the increaſe and ſupport of vegetables. In the various materials which the art and induſtry of mankind have rendered capable of being beneficially employed in this manner, there is great diverſity ; ſome are found to yield the matters which are neceſſary for the ſupport of plants much more readily and more abundantly than others, as animal, vegetable, and all ſuch ſubſtances as are rich in mucilage, ſacharine matters, and calcareous earth, and readily afford carbon, phoſphorus, and ſome aërial fluids, ſuch as have been mentioned; while others that are greatly deficient in all or many of theſe principles, or do not readily part with them, are found to be of much leſs utility, when employed in the way of manures. This is probably a principal reaſon why ſome ſorts of manures, or ſubſtances, when put upon grounds, are ſo greatly ſuperior to others, uſed at the ſame time, and in the ſame manner and proportion, a circumſtance which is frequently noticed in the practical details of huſbandry.

There are, however, many other ways in which ſubſtances, when applied to ſoils, may render them more fertile and productive, and contribute to the aid of vegetation. Some, beſides furniſhing ſuch matters as are ſuitable for the purpoſe of promoting the growth of plants, are known to add conſiderably to the quantity of vegetable and other matters contained in the ſoils on which they are placed, and thereby provide a more ſuitable and convenient bed for the reception of the roots of plants ; others contribute little in this way, but operate chiefly upon ſuch materials as are contained in them, breaking down their organization or texture, and thus ſetting at liberty different volatile and other ingredients, by which new compounds are formed, and brought to ſuch ſtates as are the moſt

* Light, heat, and probably electricity, are alſo neceſſary to the growth of plants.

adapted to the ſupport of vegetable life; others again act principally by producing certain changes and alterations in the conſtitution or texture of ſoils, ſuch as rendering them more open and porous, or more ſtiff and compact, and by ſuch means bringing them into the moſt proper conditions for the bearing of different vegetable productions; and there are ſtill others that contribute in all or ſeveral of theſe ways at the ſame time.

From the great differences that are thus met with in the principles, or in the agency, of the matters that are made uſe of as manures, it becomes difficult to adopt that ſort of arrangement which may be of utility in practice. That which ſerves to diſtinguiſh, in ſome meaſure, the nature of the materials from which they are derived, would ſeem to be of the moſt advantage in the cultivation and improvement of land; hence they may be divided into ANIMAL, VEGETABLE, FOSSIL, SALINE, and COMPOUND MANURES.

MANURES FROM THE *DECOMPOSITION* OF *ANIMAL SUBSTANCES.*

SUBSTANCES of the animal kind, when reduced by the proceſs of putrefaction, or other means, into a ſoft, pulpy, or mucilaginous ſtate, are found, by the experience of the moſt correct and able agricultors, to afford thoſe matters which are ſuited to the nutrition and ſupport of plants with greater readineſs, and in more abundance, than moſt other bodies that can be employed. By chemical analyſis it has been ſhewn that the component materials of theſe ſubſtances, ſo far as agriculture is concerned, are principally water, jelly or mucilage, and ſaccharine oleaginous matters, with ſmall portions of ſaline and calcareous earthy ſubſtances. Hence animal matters, though they agree, in ſome circumſtances, with vegetable productions, each having, in common, water, ſaccharine and calcareous matters, are far more compounded; and in animal ſubſtances, ſome of theſe materials are in large proportion, while in vegetables they only exiſt in a very ſmall degree; and the jelly, which, in ſome meaſure, reſembles the gum and mucilage of plants, differs likewiſe from them, in its having much leſs tendency to become dry, as well as in its property of attracting humidity from the atmoſphere, and of running with great rapidity into the ſtate of putrefaction and decay.

All theſe principles of animal ſubſtances are reſolved by their ultimate decompoſition into other matters, ſuch as the different gaſſeous fluids that have been mentioned above, carbon, phoſphorus, lime, &c.

It would ſeem probable, too, that in animal ſubſtances of different ſorts there may be differences in regard to the proportions of theſe ſeveral ingredients or principles. Some kinds affording one or more of them, in greater abundance than others; while others again are deficient in theſe, but abound in ſome of the others. On this ſuppoſition, the different effects of ſubſtances of the ſame claſs, when applied to ſoils of the ſame kind, may be eaſily accounted for.

Animal ſubſtances of every kind, on being deprived of their vital principle, have a quick tendency to take on or run into the ſtate of putrefaction, a proceſs which is conſiderably affected and influenced by the circumſtances under which it is produced. But in the horny and more compact animal matters this tendency to putrefaction and decompoſition is, under ſimilar circumſtances, much leſs rapid, than in ſuch as are of a leſs firm and denſe texture. The proceſs of putrefaction is, however, greatly expedited by the conditions under which it takes place being favourable; ſuch as the ſubſtance, of whatever kind it may be, poſſeſſing ſufficient moiſture, being expoſed to the free action of atmoſpheric air, and a moderate degree of heat. On various accounts it would likewiſe appear, that the decompoſition of ſuch ſubſtances may be promoted by moiſtening them with water ſlightly impregnated with common ſalt, and, perhaps, ſome other ſaline ſubſtances, ſuch as the muriats of magneſia and ſoda, or ſea-ſalt, as ingeniouſly ſuggeſted by the Earl of Dundonald *.

It is probable alſo that the decompoſition of ſome of the more hard and ſolid animal ſubſtances that are employed as manures, ſuch as horns, bones, hoofs, and rotten rags, &c. might be greatly promoted, and rendered more immediately uſeful, by being reduced into much ſmaller particles than has been uſually done, and by the application of higher degrees of heat than that of the atmoſphere.

As the diſſolution of animal as well as vegetable matters is known to be much impeded by their being excluded from the air, or expoſed to ſuch degrees of heat as are capable of drying up and taking away their moiſture, and by the mixing of ſuch earthy ſubſtances with them as are capable, from their open and porous textures, or vitriolic and other qualities, of depriving them of the fluid matters which they contain, we may ſee why, under certain circumſtances of their being mixed and applied as manures, they may prove leſs beneficial than in other inſtances.

There are ſome other circumſtances, beſides thoſe that have been mentioned, that render the decompoſition of all ſuch ſubſtances more quick and expeditious,

* See Connection of Agriculture with Chemiſtry, pp. 74 and 87.

ſuch as their being lightly depoſited together, and not in too large heaps, or with too much earth mixed and depoſited upon them, by which the air is prevented from acting upon them ſo extenſively as it might otherwiſe do. By ſprinkling common water over them frequently, eſpecially in hot and dry ſeaſons, and where they are of the more hard and compact kinds, their diſſolution, in many inſtances, might probably be rendered more quick and complete; and conſequently the food or nouriſhment of plants be more readily and more abundantly ſupplied.

Hard Animal Subſtances.—In the matters of this ſort that are employed as manures, there is conſiderable differences in reſpect to their texture and firmneſs, ſome being quite firm and ſolid, ſuch as bones, horns, hoofs, ſhavings of horn, and ſome other ſimilar ſubſtances, while others are more ſoft and pliable. The bones of all animals are capable of affording much nutritious matter to plants, but thoſe which are procured from cattle that have been killed when fat, are ſaid to be the beſt for the purpoſes of manure. Thoſe which have been boiled are far inferior, in this view, to thoſe which have not undergone that proceſs, as by ſuch means they are principally robbed of their oily and mucilaginous properties, and conſequently muſt yield much leſs nouriſhment to the immediate crop, whether it be grain or graſs. All theſe ſorts of ſubſtances require to be ground down in mills conſtructed for the purpoſe, or otherwiſe reduced into ſmall pieces, before they are laid on and mixed with the ſoil, or formed into compoſts. The uſual method is to reduce them to about the ſize of large filberts, but there can be little doubt but that they would ſooner run into the ſtate of putrefaction if they were reduced into ſtill ſmaller particles, and thus be made to afford their nutritive properties much more expeditiouſly, as well as more abundantly; by which means much leſs quantities would probably produce equally full effects with the large ones at preſent made uſe of, as where the pieces into which they are broken are left large, they remain a great length of time in the ſoil, and are only gradually decompoſed, without yielding that full ſupply of nouriſhment which is neceſſary for the ſupporting of crops. And when they have been even prepared in this way, too much earthy materials ſhould not be mixed with or applied upon them, as where this is done, by preventing the free operation of the air, their decompoſition is greatly retarded. Nor ſhould they, upon the ſame principles, when intended to be incorporated with the ſoil, be ploughed in too deeply, as by ſuch a practice the crop will be deprived of much of the advantages which it might otherwiſe have obtained from ſuch manure.

Theſe ſubſtances are conſtituted of a conſiderable proportion of mucilaginous

or gelatinous matter, a ſlight portion of fat, and an earthy ſalt compoſed of the phoſphoric acid and calcareous earth. If great heat be applied, they afford a large quantity of hydrogen gas, carbonic acid gas, and a volatile alkaline liquor. From the nature of theſe different principles, it is evident that ſome ſorts of ſubſtances may be blended and united with the reduced particles of bony matters, ſo as to promote their effects, as manures, in a conſiderable degree, ſuch as lime, chalk, peat earth, and good vegetable mould, in ſuitable proportions, as by ſuch means new combinations may be formed highly favourable to the proceſs of vegetation.

The conſuming of bony or horny ſubſtances, by means of fire, for the purpoſe of obtaining their aſhes, is a waſteful diſſipating practice that ought never to be attempted by farmers, as by it the mucilaginous and oily materials are driven off and loſt, and nothing remains but a phoſphat of lime, which can be of but little uſe in promoting the growth of vegetable crops.

Soft Animal Subſtances.—There are various matters of this nature that may be of uſe for the purpoſe of improving land as manures, ſome of which have yet been but little attended to by the farmer. Of this ſort are *greaves*, or the reſiduum which is left after the making of candles, and the *ſcum* which is collected in the boiling or refining of ſugar.

Different trials, upon a ſmall ſcale, with the former, have fully convinced us that it is a ſubſtance that poſſeſſes great powers, when employed as a manure. And although it is a ſubſtance which is generally procured at a high price; from its going a great way, and being a laſting manure, it may, probably, be more frequently had recourſe to than has hitherto been the caſe. It is moſtly procured in the ſtate of hard compreſſed ſquare cakes, though ſometimes in a ſoft condition, without having undergone any preſſure. When in the former ſtate, the cakes muſt be broken down and reduced into as great a ſtate of diviſion as poſſible, which may be rather a troubleſome and expenſive proceſs, except a mill, or ſome proper machine for the purpoſe, be employed. But when it has been even reduced to the fineſt ſtate poſſible, it will ſtill be improper for application as a manure, until it has been mixed and incorporated with a pretty large proportion of ſome rich earthy ſubſtance with which it may combine. In the attempts which we have had an opportunity of making with this animal ſubſtance, after being much reduced, it has always been blended in the proportion of three or four parts of good vegetable mould, according to the condition of the land, to one of the greaves, and then ſown

as a top dreſſing on graſs land, where it has never failed to produce a full crop of hay, conſiderably greater than that by the uſual dreſſings of dung, and a rich ſweet after-graſs, or ſuch as cattle were remarkably fond of feeding upon.

In a very obliging communication on this ſubject, from an able and intelligent practical agricultor, Dr. Wilkinſon, of Enfield, it is conceived that the animal kingdom furniſhes the ſtrongeſt manures, among which he has found greaves to be the moſt powerful and durable in their effects. From one ton to a ton and a half, he conſiders as ſufficient for an acre, according to the ſtate of the land. The cakes in his practice are, he ſays, minutely divided, which on account of their hardneſs is an expenſive and laborious operation; and that even in this ſtate of minute diviſion, unleſs mixed with mould, they frequently prove too ſtrong for corn, as he found by experience, on applying them to barley, the grain of which was injured by the rankneſs of the ſtraw. They are, he conceives, peculiarly adapted to promote the growth of graſs, turnips, and the leguminous plants.

Eight acres of pebbly loam were, he remarks, manured with dung, at the rate of ten loads of the common Middleſex carts per acre, except one acre of the pooreſt and moſt gravelly, which was dreſſed with a ton and a half of greaves. The turnips where the greaves were ſpread, and the ſucceeding barley (which were the crops on the whole piece), were thicker and more vigorous than where common dung had been laid. He has obſerved graſs rendered ſo rank by the uſe of greaves as a manure, that cattle would not touch it till mellowed by the winter's froſt; and even in the ſucceeding year he was able to trace, by the ſuperior verdure of the graſs, to what extent this manure had been ſpread. He has alſo uſed with ſucceſs, he ſays, ſalted fiſh proviſions, and particularly herrings, which had been ſpoiled on ſhip-board, and has found them equal to the greaves. In the ſame manner he has uſed ſalted meat that had become putrid on a long voyage. His general mode of application has, he ſays, been to mix them with mould raiſed from the headlands of the field where they were intended to be ſpread. By letting them lie for ſome time, the earth imbibes the ſtrong ſmell and virtues of the animal manure. Over theſe he has ſpread, with advantage, the liquor drawn from the greaves, and the waſhings of the caſks of ſalt meat which had been ſpoiled. When ſprinkled immediately over graſs in the ſpring, he has alſo obſerved this liquor attended with conſiderable efficacy in producing a plentiful crop of hay.

Laſt year, 1800, he ſays, he uſed with ſucceſs a combination of lime

and greaves, mixed with mould from the headlands, in the proportion of about fifty buſhels of lime to a ton of greaves. This compoſition, he obſerves, reſembles *ſugar ſcum*, which conſiſts of lime and bullocks' blood.

From the large experience he has had of the benefits ariſing from ſugar ſcum, he thinks this combination of lime and animal matter deſerves further inveſtigation.

There can be little doubt but that by combining lime with animal ſubſtances, they may be rendered highly active as manures, eſpecially when applied on ſoils that have a ſufficiency of thoſe earthy ſubſtances on which they can exert their full influence.

In this way they ſeem frequently to be rendered more active than when employed in a ſimple uncombined ſtate; but experiments are perhaps wanting to fully aſcertain the utility and beſt means of employing ſuch matters.

Lime might thus be combined with bones or woollen rags, or with a compoſt of earth and night-ſoil; and would certainly greatly facilitate their converſion into manure, as well as render them more active in producing their effects in the ſupport of vegetable crops. And by ſome of their properties being abſorbed by the lime, during the time of their decompoſition, and afterwards parted with more ſlowly in the ſoil, they may alſo by ſuch means be, probably, rendered more durable and laſting, as manures.

It is further obſerved, by this experienced agriculturiſt, that the Arabians, who take great pains to improve their lands, are accuſtomed to make large pits; they then put in animal ſubſtances, and cover them with calcareous or clayey earths, and afterwards theſe earths, which of themſelves are ſterile, acquire the properties of the richeſt manure. He ſays, he once ordered a heifer which died in a field at a diſtance from his houſe, to be buried in a compoſt of lime and earth; he does not aſſert that this was its moſt profitable application; he had, however, no reaſon, he ſays, to complain of his compoſt.

Mr. Wight, in his Survey of the Huſbandry of Scotland, he obſerves, mentions a compoſt of two parts lime, and one part pigeons' dung, to remain mixed until a conſiderable fermentation advances, which is known by the effluvia. Six bolls of this compoſt, he ſays, is ſufficient for an acre, and will mark itſelf for many years.

There are many combinations of this nature that may be ſucceſsfully made uſe of for the purpoſes of agriculture, but which have not yet been ſufficiently attended to, to aſcertain their different effects.

There are ſtill more ſubſtances of the animal claſs, ſuch as the *refuſe of glue-makers*, the *cuttings of felt-mongers*, the *clippings of furriers*, the *ſcrapings of oiled-leather*, and the *chips or waſte of ſhoe-makers*, which may be made uſe of as manures, when they can be collected in ſufficient quantities. Theſe animal materials, from their abounding in mucilage and oil, their great attraction for moiſture, and their being readily ſoluble in water, contribute quickly to the ſupport of vegetation, but are not probably ſo durable in their effects upon land, as many other ſubſtances. Hence they ſhould only be made uſe of with a view to the immediate crop, which, we believe, is pretty much the caſe in thoſe places where they can be obtained in ſuch quantities as to be employed for the purpoſes of agriculture.

Various animal ſubſtances of the fiſh kind, as the blubber remaining after the preparation of oil from the whale, and other large fiſhes, and different ſorts of ſmall fiſh, both of the ſhell and other kinds, may be employed as manures; and alſo the offals of ſuch animals, where they can be procured in a large quantity, as in large towns, ſea diſtricts, and where they are cured or prepared in great numbers for the market.

Theſe ſubſtances may be readily reduced to that ſtate which is proper for manure, by mixing with them a ſmall portion of the carbonat of lime, and afterwards, according to circumſtances, a quantity, two or three times more than the whole, of good vegetable mould. Shell-fiſh, ſuch as muſcles, are commonly applied without being mixed with earthy matters; but this is certainly a waſteful practice, as much of their valuable principles is diſſipated and loſt, as is evident from the highly diſagreeable ſtench that aſſails the neighbourhood of the ground on which they have been applied. By mixing good vegetable mould or peat earth with them, as has been mentioned above, the quantity of the manure would not only be greatly increaſed, but the offenſiveneſs attending the uſe of ſuch manures, in a great meaſure, corrected, and the effects of them in promoting the growth of vegetables probably rendered more advantageous.

The refuſe of ſlaughter-houſes and butchers' ſhops may, likewiſe, be prepared and made uſe of in a ſimilar manner to that of fiſh. For as the manures that are formed from theſe animal materials are capable of affording much elaſtic volatile matters during their decompoſition, they of courſe require to be well mixed and blended with ſuch earthy ſubſtances as they can combine with, and render ſoluble, and in proportions ſuited to their powers, in order to produce the moſt beneficial effects on vegetation.

It is probable that woollen-rags, hair, feathers, and ſuch-like ſubſtances, from their having a leſs portion of oily or mucilaginous matter in their compoſition, are inferior as manures. The firſt muſt be cut or chopped into ſmall pieces before it can be advantageouſly applied to the ground.

From the experiments that have been made with ſuch animal ſubſtances as have been mentioned as manures, it may be inferred that their effects continue longer than thoſe of many ſubſtances of other kinds. Dr. Hunter found from the application of reduced bones to a poor calcareous ſoil, with a grain crop, in the proportion of ſixty buſhels to the acre, that the crop was much ſuperior, when this was uſed, to that which had not been dreſſed in the ſame way, and the graſs crops afterwards for ſome length of time, on the ſame place, diſplayed a ſuperiority, and appeared more early. He alſo found the ſame ſuperiority in turnip crops in different fields, when dreſſed in the ſame way. Mr. Young likewiſe found the effects of bone manures to be very great; but they did not correſpond to the quantities employed, as with twenty-five cart loads the crop was better than with fifty*. This curious fact is, however, explained, by his obſerving that the ſoil was an extremely poor one, as in ſuch a caſe there could only be a ſmall proportion of earthy matter for the ammonia and other ſubſtances afforded by the decompoſition of the bones to act upon, and reduce to that ſtate of ſolubility the moſt adapted to the ſupport of vegetation. Hence the immediate benefit that was derived from the manure, probably, depended ſolely on the oily and mucilaginous materials.

Where bony ſubſtances are not broken down into very ſmall particles, we ſuſpect, from ſome few trials that we have been enabled to make, that the effects of ſuch ſubſtances will be equally, if not more, apparent the ſecond than the firſt year, whether they be uſed on graſs land, or that which is under the plough. The trials which Dr. Hunter made with ground and unground bones ſeem, likewiſe, to ſupport this opinion, as he found that, for the immediate crop, the unground bones were of little or no ſervice, but the ground ones of much benefit. What effect the unground ones had the ſecond year is not exactly mentioned; however, from his concluding that theſe ſubſtances are, in general, upon graſs land, more effectual the ſecond than the firſt year, it may be eaſily ſuppoſed to have been the caſe.

Animal dungs.—The animalized ſubſtances that are, however, moſt generally

* Annals of Agriculture, vol. III. p. 69.

made uſe of as manures, are the excrements of various kinds of animals, which are found in very different conditions, or ſtates of preparation and richneſs, proceeding, in ſome meaſure, from the kind of food on which the animal has been fed, the matters with which they are incorporated, and the texture of the ſubſtances themſelves.

It is ſtated by a very correct practical obſerver, that the dung of fat animals is unqueſtionably more rich, and conſequently poſſeſſes greater powers of fertilization, than the dung of lean ones; and that the quality of the dung of every ſort of animal will, in a great meaſure, be proportioned to the goodneſs or poverty of its food. Thus, when the animal is fed on oily ſeeds, ſuch as lint, rape, and others of a ſimilar nature, it will be the moſt rich; when kept on oil-cake, or thoſe ſeeds which have been deprived of part of their oily matter, the next ſo; on turnips, carrots, and ſuch-like vegetable roots, the next; on the beſt hay, next; on ordinary hay, next; and on ſtraw, perhaps, the pooreſt of all. The dung of lean hard-working cattle, feeding on ſtraw, muſt, he conceives, be poor indeed*.

Some manures of this kind, ſuch as the ſoil of privies, is ſometimes met with in a ſtate fit to be applied to the ground, when not much mixed with fluid matters, ſuch as urine. It moſt frequently happens, however, that it is in ſuch a liquid ſtate as to require other more ſolid ſubſtances to be blended with it, before it can be conveniently applied to the ſoil. In doing this, too little regard ſeems to have in common been paid to the choice of the moſt proper materials: but it is obvious, that ſuch as can be the moſt fully acted upon, and the moſt readily converted into the ſtates ſuitable for affording the nutrition of vegetables, by the principles of the matters thus employed as manures, muſt be the moſt adapted for the purpoſe, as well as the moſt beneficial. When, therefore, the manure made uſe of in this way is either wholly or principally conſtituted of ſuch animalized matters as, from their fluidity, are in an improper ſtate or condition to be ſet on land without having other ſubſtances previouſly mixed with them, ſuch peaty, boggy, or black vegetable earths ſhould be choſen as contain large proportions of matter, which the ammonia or volatile alkali ſo abundantly provided by the decompoſition of ſuch ſubſtances may exert itſelf upon, and reduce into that ſtate of ſolubility which is ſuitable for promoting the growth of plants. By duly attending to this practice, which has been ſo ſcientifically handled by the Earl of Dundonald†, much

* See Middleton's View of the Agriculture of Middleſex, p. 30.

† See Treatiſe on the Connection of Agriculture with Chemiſtry.

advantage may be gained, not only in the quantity, but likewiſe in the quality of the manure.

The reſults of experiments attentively made in this way, indeed, clearly demonſtrate that an inconceivable loſs is incurred by the inconſiderate practice of exſiccating human excrement, as well as the negligent cuſtom of permitting the liquor or fluid parts of dung heaps to run away. The trials which we have been enabled to make alſo lead us to ſuſpect, that it is a much more waſteful practice to apply theſe liquors to ground in their uncombined ſtate, than in conjunction with ſuch earthy materials as have been mentioned above. Beſides, much of them muſt be imperceptibly carried off by the proceſs of evaporation, even when they are carried out in the moſt favourable ſeaſons of the year; and they cannot in this way always be made uſe of on thoſe ſoils that contain a ſufficient quantity of thoſe earthy materials, or principles, with which they can readily form combinations, and exert their moſt beneficial and fulleſt effects.

Moſt of the later practical writers on agriculture are decidedly of opinion, that the *ſoil of privies* is a manure of the moſt enriching kind, but that its effects are not ſo laſting as thoſe of many other ſubſtances. In the trials which have been lately made with it, by a very ingenious and experienced agriculturiſt*, it is ſaid to have produced ſuch aſtoniſhing fertility as to induce him to conclude that it exceeds all other ſorts of manure that can be put in competition with it for the *firſt year* after its application. The ſecond year he thinks it of *ſome* ſervice, but in the third its effects nearly, if not quite, diſappear. The circumſtances which render this ſort of manure ſo immediately active in promoting vegetation, and ſo quickly deprived of its beneficial influence, would ſeem to be from the great quantity of elaſtic principles which it contains, in a looſe ſtate of combination, and the ſmall quantity of earthy matter which it is capable of ſupplying to the ſoil, by the laſt ſtages of decompoſition or decay. This alſo further ſhews the advantage of mixing and incorporating with it ſuch kinds of earthy ſubſtances as it may be capable of acting upon, and uniting with. From the cauſes juſt noticed, its moſt active and nutritious properties are almoſt immediately ſet at liberty, and either directly contribute to the growth of plants, or form ſuch new combinations as readily become uſeful for the purpoſe, while but very little of the earthy material is left behind for further decompoſition, and the durable aid of vegetable increaſe. The author mentioned above alſo further remarks, that this matter is not only prepared in the moſt ſuitable manner for the purpoſe of

* Middleton in Tranſactions for the Encouragement of Arts, &c. vol. XVII. p. 236.

perfect vegetation, but that the herbage produced by it is capable of fattening the *largeſt* cattle in *leſs* time than any other. And we know from repeated experiment, that the fineſt garden vegetables may be produced by it, when properly employed, without the leaſt injury to their taſte, even in the moſt delicate of them, ſuch as cauliflowers, white brocoli, &c. Inſtead of a bad taſte being communicated to herbage by the uſe of this manure, it would ſeem, probably, that it conſiderably improves its flavour, as it has been obſerved that the patches of ſuch paſtures as had been manured with this ſubſtance were conſtantly eaten *quite cloſe* by horſes, cows, and young cattle, while in other places there was much *longer graſs**.

From theſe facts, the importance of this ſubſtance, as a manure, is evidently ſuch, that every poſſible means ſhould be contrived to prevent its loſs, which is ſhamefully permitted, at preſent, to take place in many large towns, to the aſtoniſhing extent of more than two thirds of the whole, and ſome method made uſe of to render its conveyance and application more general and convenient, which cannot be a matter of much difficulty, if once the attention of practical agriculturiſts be properly excited upon the ſubject, as we ſhall have occaſion further to remark when we come to conſider the means of augmenting and preſerving manures.

The dungs of thoſe animals which feed on ſuch ſorts of food as conſtitute either wholly, or in a great part, the food of man, as has been noticed above, are found, from the experience of practical farmers, to be more effectual in promoting vegetation, when applied as manures to ground, than thoſe of ſuch animals as are ſuſtained by ſuch kinds of matters as are ſeldom or ever made uſe of in that way; hence it is obvious that the dungs of carnivorous birds, dogs, ſwine, horſes highly fed, poultry, pigeons, and ſuch-like animals, muſt be more powerful in their effects as manures, than thoſe of horſes when fed only with hay or graſs, neat cattle, ſheep, and other animals that live in the ſame manner. On the ſame principle too, it ſeems not improbable, but that the excrements of inſects may be leſs efficacious as manures than their bodies, as it is well known that by their deſtruction and decompoſition the fertility of land is conſiderably increaſed in particular inſtances.

It is probable, likewiſe, that the dungs of ſome animals may, from the ſtate of their ſtomachs and other cauſes, as well as the nature of their food, be more completely reduced and animalized in its paſſage through their bodies

* See Annals of Agriculture, vol. I. p. 655.

that this is the caſe, at leaſt, in granivorous birds, in which the food is ſubjected to conſiderable trituration in the courſe of its digeſtion, there can be little doubt, and thereby they perhaps become, in ſome meaſure, in a condition more ſuitable to form new combinations, or afford the ſupport of vegetation.

This view of the nature of the manures afforded by different animals, ſhould lead the practical agriculturiſt to be more attentive to the ſubject, in order that he may render them more abundant, and be capable of employing them under the moſt favourable circumſtances, which cannot be the caſe while they are, as at preſent, indiſcriminately mixed and blended in the common dung-heap. That they ſhould not be uſed in this way is clear from the contradictory accounts of them that have been preſented to us by various writers and experimenters, which would ſeem to have been cauſed by employing them in ſtates of mixture with other ſubſtances. By ſome it is aſſerted that one load of *ſwines' dung* is nearly equal to two of moſt other ſorts, and that it is the richeſt of all animal manures; in this, however, they would ſeem to be miſtaken, as from trials made by others, it has been ſhewn that *night-ſoil* is certainly to be ranked much before it. In ſome of the ingenious experimental attempts of Mr. Young, it is alſo ſhewn that the dungs of rabbits and poultry are ſuperior to that of pigeons, and greatly more durable*. But poultry dung, in the comparative experiments of Mr. Arbuthnot, was found to be more effectual than that of rabbits, and that of the latter greatly ſuperior to wood aſhes. *Pigeons' dung* has, notwithſtanding, been proved by much experience to be a powerful and efficacious manure, and probably, from its abounding with volatile alkaline principles, been concluded to be of a hot or ſtimulating quality.

It is, however, from the larger animals that the farmer derives the principal part of the dung that is made uſe of as manure, in the cultivation and improvement of land. The dung of ſuch horſes as are highly fed being found, as has been already ſeen, to be much more valuable for the general purpoſes of agriculture, and ſome uſes in horticulture, than that which is made by horſes when fed with hay or graſs only. Where the animals are kept in the latter way, it is, probably, not ſo good as that of well-fed cows and neat cattle in general, as in theſe it may, perhaps, become more animalized from the circumſtance of their food being more intimately blended with the *ſaliva*, or other juices, during the ruminant ſtate of feeding in ſuch animals. The dung of

* See Annals of Agriculture, vol. II. p. 26.

horſes is, however, in common, much more diſpoſed to take on the proceſs of putrefaction, and cauſe more heat, than that of cows and other neat cattle, and indeed theſe are the chief diſtinguiſhing circumſtances between them as manures. The dung of neat cattle may alſo, on account of its leſs diſpoſition to run into the ſtate of putrefaction, contribute more of the earthy material to the land on which it is applied. Hence, probably, its ſuperior utility on the leaner and poorer or thinner ſorts of ſoil. The dung and urine of animals when newly voided are not, except when the animals are morbid, in a putreſcent condition, the length of time in which they remain in their bodies being too ſhort for its fully taking place; but ſome degree of, or tendency to, putridity is conſtantly neceſſary to their diſcharge*, and the means which are further ſuited to promote it in theſe ſubſtances, have been fully deſcribed and explained above, in ſpeaking of the nature of animal ſubſtances in general.

From the few experiments that have been made with the dung of ſheep, it is evident that it is equally valuable with that of many other animals that feed in the ſame way, but agriculturiſts have not yet turned their attention ſufficiently to the means of collecting and preſerving it, ſo that it may be uſed alone as a manure. The method by which it is at preſent applied to land is by folding the animals upon it, under which method of management, on many ſoils, a great part of the advantage muſt be derived from the operation or action of the ammonia of their urine upon the vegetable matters contained in them, as well as from the conſolidation produced by their treading.

MANURES FROM THE *DECOMPOSITION* OF *VEGETABLE SUBSTANCES.*

VEGETABLE, as well as animal, ſubſtances, when deprived of their vital principle or life, are ſoon rendered fit, by the ſeparation, reduction, and ultimate decompoſition, of their conſtituent principles, for the nouriſhment and ſupport of new plants. In this proceſs, which we have already ſeen to be greatly promoted in all kinds of ſubſtances by the materials being expoſed to the free influence or agency of atmoſpheric air, moiſture, and a middling degree of heat, various matters are ſet at liberty, by which different new combinations take place, that are capable of promoting vegetation in different degrees, and upon which their utility as manures, perhaps, chiefly depends. The ſtages of this

* See Dundonald on the Connection of Agriculture with Chemiſtry, p. 100.

decompoſition have generally been ſuppoſed to regularly ſucceed one another, from that which is productive of ſweetneſs, through the vinous and acetous, to that which is the ultimate reſult of putrefaction. But a late philoſophical writer* ingeniouſly ſuggeſts, that it is more probable that different ſorts and parts of organiſed matters, when dead, may undergo many different ſorts of chemical changes, and that theſe may be different according to the differences in the degrees of heat, the quantity of water, and of air, to which they are expoſed. He appears to have been led to this ſuppoſition from the ſaccharine proceſs, preceding the vinous fermentation, which takes place in certain ſtates of animal ſtomachs; and from what happens in the germination, or ſprouting, of grain, by which the mealy matter is converted into ſugar. From remarking that the acerb juices of ſome kinds of fruit are rendered ſweet by baking, he conceives, that the ſaccharine proceſs may take place in a degree of heat which is about that of boiling water, and that by it the proceſs of fermentation may be altogether prevented from occurring. By deſtroying or injuring the life of fruits, it is alſo ſuppoſed, that the ſaccharine proceſs of their juices may be promoted, as is found in many inſtances; ſuch as the ripening of fruits after being plucked from the trees; their being ſooner ripened after being injured by inſects, or other means; and after partially cutting, or otherwiſe injuring, the branches of the trees on which they grow: and this, which is termed the ſaccharine proceſs, it is conjectured, may take place either beneath or upon the earth, in the incipient ſtate of vegetable decompoſition, before the vinous fermentation, and thus afford a very nouriſhing matter to plants.

In the vinous, or proceſs which commences after the ſaccharine, carbon becomes united with pure air in a large proportion; and it is ſuppoſed, by the author we have juſt mentioned, that probably at the moment of their combination, while they are in the form of a liquid, and before they aſſume the gaſſeous ſtate, they may be taken up by the roots of vegetables.

And, as in the proceſs of putrefaction, carbon is not only changed into carbonic acid, but water decompoſed, as is evinced by the ſmell of hydrogen, it is ſuſpected that that inflammable ſubſtance may combine with carbon, as in the caſe of hydrocarbonate gas, and by this means render them both ſoluble in water, and thereby capable of being taken up as food by the roots of plants, without their paſſing into the acid or gaſſeous ſtates. The union of azote with

* See Darwin's Phytologia, p. 229.

pure air, towards the cloſe of the putrefactive proceſs, by which nitrous acid is produced, it is likewiſe conceived may poſſibly tend to promote vegetation. This, however, may be promoted, from the circumſtance of the pure air, or oxygen, adhering more looſely to its baſe, the azote, in the formation of this than other acids, and on that account yielding it more readily to the abſorbent roots of vegetables. But, beſides theſe means of ſupplying the nutrition of plants, as in the decompoſition of vegetable ſubſtances by the proceſs of putrefaction, the conſtituent principles of the water which they contain are, as has been juſt obſerved, in ſome meaſure ſet at liberty, and the hydrogen, one of them, uniting with the azote which is afforded by the diſſolution of vegetable matters, though not in ſuch large proportions as by animal ſubſtances, forms ammonia, which, from its ready union with fats and oily matters, and thus rendering them capable of being taken up by the abſorbent roots of vegetables, may contribute to the ſupport of vegetation. And, in ſome inſtances, where ſaline inſoluble earthy matters, or metallic ſalts, are contained in the ſoils to which manures of this kind are applied, or in which ammonia may be formed, it may decompoſe them, and by that means contribute to the formation of other new and leſs noxious compounds, or ſuch as may be more capable of contributing to the growth of vegetables.

There is another ſubſtance which generally prevails in vegetables, and which is ſuppoſed, by the writer we have noticed above, to be a ſimple material, obtained in great abundance from the recrements not only of putrefying vegetable, but animal ſubſtances, and calcareous earth, the latter of which he ſuppoſes to have been of animal origin in the early periods of the world. This matter, it is thought, when met with in the ſtate of ſolution, may be taken up entire by the abſorbent roots of vegetables, as well as occaſionally formed and elaborated by them.

It ſeems probable from theſe ſtatements, that different matters, fitted to the nutrition and ſupport of plants, or crops, are formed and evolved during the different proceſſes and ſtages of decompoſition of vegetable, as well as animal, ſubſtances.

In vegetable productions the changes are, however, leſs rapid than in thoſe of the animal kind, and probably much more varied, according to the various ſtates and textures of the particular ſubſtances; for it is obvious, from numerous facts and circumſtances, that the more luxuriant and juicy vegetables are much more readily decompoſed than ſuch as are dry, and have a ligneous ſtruc-

ture. Hence it is, that freſh vegetable matters are much more quickly converted to that ſtate of decay which is ſuitable for the ſupplying of vegetable nouriſhment, than ſuch as ſtraw, hay, wood, and other dry materials of the ſame nature.

It ſeems likewiſe probable, that ſome vegetable matters may yield ſome of the ſubſtances that are taken up by the abſorbent roots of vegetables in much larger proportions than others; as it has been found that different ſorts of grain vary conſiderably in the proportions of mucilaginous, and what is termed vegeto-animal matter, which they contain; and that grain, potatoes, carrots, and many other roots of the ſame kind, on being conſumed in the open air, afford much larger quantities of alkaline ſalts than hay, ſtraw, or wood: it is undoubtedly from theſe and ſimilar cauſes, that ſome ſorts of vegetable matters, when reduced by means of putrefaction, are found to be ſo much more effectual as manures than others, when applied under the ſame circumſtances, and to ſoils in every reſpect ſimilar.

There is alſo another circumſtance which ſeems neceſſary to be attended to in ſubſtances of this claſs, which is, that in general, when reſolved by the ultimate proceſs of putrefaction, they yield larger proportions of earthy materials to the ſoils on which they are depoſited, than moſt ſubſtances of the animal kind, and conſequently add more effectually to the ſtaple of the land. And as this vegetable mould, or earth, from various cauſes, is conſtantly becoming more extenſively, and more intimately, blended with the other materials of the ſoils, and, of courſe, forming new combinations, by which ſome of thoſe matters which ſerve for the nutrition of plants are ſet at liberty, and brought into the ſtate moſt proper for being abſorbed by the roots of vegetables; we ſee why thoſe manures, which are principally compoſed of vegetable ſubſtances, are more durable in their effects than ſuch as are prepared from many animal materials.

The ſubſtances of the vegetable kind that may be advantageouſly converted into manure, are ſo extremely numerous that it is impoſſible to deſcribe the whole of them. All kinds of green vegetable productions may be employed in this way; ſuch as the luxuriant weeds of rivers, lakes, ponds, and ditches; fern; and the refuſe of different kinds of garden vegetables. Where green materials of this nature are made uſe of, they ſhould always be cut down while in their juicy ſtate, juſt before their flowers begin to appear, in order that they may be in the moſt ſuitable condition for becoming quickly putrid, and to prevent the injury that might otherwiſe be ſuſtained from the vegetation of their ſeeds. They are afterwards to be collected into heaps of a moderate ſize, and their putrefaction promoted

by their being thrown together as lightly as poſſible, and the occaſional ſprinkling of them with water, if the ſeaſon be hot and dry: and as lime is found, when applied to vegetables in their green moiſt ſtate, to diſengage from them both hydrogen and azote, by the combination of which volatile alkali is produced *, it may be advantageous to blend a portion of lime at firſt with the heaps, and afterwards add a ſuitable quantity of peat-earth, or good vegetable mould, for the alkali thus formed to act upon. By this method, the quantity of manure from ſuch ſubſtances may be greatly augmented, and rendered more valuable. But when dry materials, ſuch as hay, ſtraw of different kinds, fern, and ruſhes, ſuch additions cannot be had recourſe to with equal ſucceſs, unleſs where much of the dung and urine of animals have been incorporated with them; but their reſolution and decay may be greatly promoted by their being kept in a ſtate of moiſture, without the water being ſuffered to ſtagnate upon them, and by their not being permitted to be trodden down too much by cattle, or other means, in the farm yards.

Another beneficial means of vegetable manure, which is yet far from being ſufficiently practiſed, is that of providing full crops of ſucculent green vegetables, ſuch as clover, buck-wheat, tares, vetches, ſpurry, peaſe, beans, turnips, and many other ſimilar plants, to be turned down by the plough, in order that they may undergo the putrefactive proceſs under the ground, and by that means be converted into manure, and ſupply the nutrition of plants. In this practice it is probable that great advantages might be obtained, on the principles which we have juſt ſtated, by the ſpreading of a ſmall portion of lime and peat, or rich vegetable earth, over ſuch crops, and then rolling them down that they may be completely turned in and buried by the plough; an operation which ſhould be performed as quickly as poſſible afterwards, and where the crops will admit of it, in the ſummer or the early part of autumn, while the ſun has the power of promoting the decay of ſuch vegetable matters. By this means, it ſeems probable, that the putrefaction of ſuch crops would not only be much expedited, but the principles thereby ſet at liberty be capable of exerting their influence much more extenſively than where the plants themſelves are only employed, and little additional expence be incurred by the farmer.

Where crops of green plants can be turned down, when the ſeaſon is ſufficiently hot to enſure their ſpeedily running into the putrid ſtate, there cannot be any doubt but that it is a better and more advantageous practice, eſpecially

* See Dundonald on the Connection of Agriculture with Chemiſtry, p. 42.

where manures of other kinds are ſcarce, than that of procuring it by the conſuming of ſuch crops by the feeding or ſoiling of cattle.

Sea-weed * is another vegetable production which is capable of being employed as a manure with great advantage, and ſhould never be neglected where it is within the reach of the farmer. In ſome places it is the practice to ſpread it upon the lands as ſoon as poſſible after being cut from the verges of the rocks on the different ſea coaſts, or collected after being left by the tides, and to plough it in: where this method is adopted, as little time as poſſible ſhould be ſuffered to elapſe after the cutting, or collecting, of the weed, before it is ploughed down; for as the plant in its green or ſucculent ſtate readily decays and becomes putrid, if there be any conſiderable delay in the performance of the buſineſs, eſpecially when the weather is hot, much of its valuable properties as a manure is diſſipated, and carried away by means of evaporation, as is ſufficiently evinced by the pungent and diſagreeable ſmell that iſſues from it, on its being thrown upon the land while undergoing the proceſs of putrefaction: and, beſides, when it is ſuffered to become dry and hard before it is turned into the ground, the parts of it that remain are conſiderably longer before they become decompoſed and reduced into the ſtate ſuitable for affording the nouriſhment and ſupport of vegetable crops. It is moſt probably on theſe accounts, as well as that of the weed affording but little earthy matter in proportion to its bulk, on its decompoſition, that it is found, in general, to be leſs permanent in its effects, as a manure, than ſome other vegetable matters. Something may likewiſe depend on the goodneſs and luxuriance of the weed itſelf, and the ſtate which it is in when gathered from the ſhores, or cut from the ſides of the rocks. This, like moſt other plants, will undoubtedly be in the moſt proper condition for the purpoſes of being converted into manure, when cut or collected in the moſt ſucculent ſtate of its growth †.

Another practice, which prevails in ſome diſtricts where this weed is employed for the purpoſe of manure, is that of collecting it into large heaps, and letting it remain expoſed in that ſtate to the influence of the weather until it be completely rotten, and in a condition to be put upon the land; but as the plant contains in its compoſition a large proportion of ſaline matters, which during the ſtate of its decompoſition, or decay, are brought into activity, it is obvious that by ſuch a method of proceeding much loſs muſt be ſuſtained, not only from

* *Quircus Marina.*

† See Sir John Sinclair's View of the State of Agriculture in the Northern Counties of Scotland, p. 21.

the diſſipation of the volatile and more fluid parts by the action of the ſun and wind, but by the rains diſſolving and carrying away the ſaline materials that may have been formed. When this weed is, therefore, not to be immediately applied as a manure, it would ſeem to be the moſt economical and advantageous plan, eſpecially where the weed is freſh, to firſt blend a portion of quick lime with the heaps, and then have a ſufficient quantity of freſh good earth, mould, or other ſimilar matters, placed beneath them, as well as mixed with and covered over them, in order that the ſubſtances afforded by the diſſolution of the weed may not only have ſomething to mix with and act upon, but likewiſe be prevented from being waſhed away by rains. By this means the quantity of manure may be very much increaſed, and its effects rendered conſiderably more permanent.

In the iſlands of Jerſey and Guernſey, where this weed is extenſively employed as a manure, it is cut in the early part of the ſpring, and about the month of July; the firſt cutting is, in moſt caſes, immediately made uſe of, as a manure for barley and paſture lands, but the latter, principally converted to the purpoſe of fuel, the aſhes only being employed as manure. By this practice of conſuming the plant in its dry ſtate, however neceſſary it may be in theſe iſlands, from the great ſcarcity of fuel, the loſs in reſpect to manure is extremely great, as the quantity of aſhes that are thus produced, bear but a very ſmall proportion to that of the weed which is conſumed. The weed which is collected after having been thrown upon the ſhore by the tides, is found to be much inferior as a manure to that which is cut from the rocks and made uſe of in its juicy ſtate, which fully confirms the opinion which has been advanced above.

Bark, which has been made uſe of for the purpoſe of tanning leather, may likewiſe be employed as a manure: when uſed in this way it ſhould be collected into moderate ſized heaps, before it has become dry by too much expoſure to the heat of the ſun and wind; and then by having a quantity of lime mingled with it, and being kept ſlightly moiſtened with water, its putrefaction and decay may be greatly promoted. When intended to be applied to graſs lands, it ſhould be conſiderably more reduced towards the ſtate of vegetable mould than when made uſe of for the purpoſe of ſupporting arable crops.

As during the decompoſition of this ſubſtance much heat is produced, and many elaſtic matters ſet at liberty, it would ſeem that as a manure it is more adapted to the ſtiff, cold, and heavy ſoils, than thoſe of the lighter kinds; a fact which has, we believe, been confirmed by the experience of moſt agriculturiſts.

The mud taken from the bottom of rivers, ponds, and other places, where water has ſtagnated for ſome length of time, freſh or maiden earth, and the ſcourings of old ditches, are ſubſtances that may frequently be employed with advantage as manures, being principally compoſed of the recrements of decayed vegetable matters. They ſhould not, however, be put upon grounds, eſpecially thoſe under graſs, until they have been reduced into a conſiderable degree of fineneſs, by means of frequent turning over, and the mixing of a portion of lime, rotten dung, or other materials of the ſame kind, with them, in order to promote and render the decay of the more ſolid parts more full and complete. In uſing manures prepared from ſubſtances of this ſort as top dreſſings for graſs land, they ſhould not be ſpread on too thickly, or in too large proportions at one application, as where that is the caſe great injury is often done to the ſucceeding crop, the graſs not being able to ſpread itſelf completely over the ſurface.

The duſt which is ſcreened from malt, mixed with the tails, uſually denominated *coombs*, where they can be procured in large quantity, as in the malting diſtricts, may be converted to the purpoſe of manure. It is obſerved, in a paper by Mr. Farey, in the Annals of Agriculture, that the black malt duſt, ſuch as falls through the kiln-plate in the operation of drying, is greatly preferable to the white, on account of the ſeeds of charlock, with which it abounds, being deſtroyed by the heat: but, beſides this, the heat thus applied may, by deſtroying the vegetative principle of ſuch ſeeds where they exiſt, render them and the duſt more readily diſpoſed to take on the proceſs of decay and become putrid, and thereby afford the nutrition of vegetables more quickly, as well as more abundantly. This, as well as ſaw-duſt, where they can be had at a cheap rate, may be conſiderably improved as manures by incorporating them, in pretty large quantities, with the dung and urine of animals, as by ſtrewing them in the bottoms of poultry and pigeon houſes, dung heaps, and neceſſaries; and alſo in the bottoms of reſervoirs into which the urine of cattle, and the ſoapſuds after waſhing, are emptied: from the action of theſe matters upon them, they are found to become more quickly in a ſtate to be uſed with advantage as manures. Manure of this ſort has been found very beneficial when applied in the proportion of four quarters to the acre, ſown with the crop for which it is employed *.

The huſks, or cakes, which are left after different oily ſeeds, ſuch as thoſe of rape, cole, &c. have been ſubjected to preſſure in mills in order to obtain their

* See Letters and Papers of the Bath Agricultural Society, vol. III.

oil, may alſo be uſed as manures. Theſe ſubſtances are generally prepared for application by being reduced into the ſtate of a coarſe powder, by mills or other ſuitable means, and then ſown by the hand, and harrowed in with the ſeed of the crop for which they are uſed. Some agricultors, however, recommend their being mixed, when thus reduced, thinly, with the materials of ſuch dung-hills as are deficient in point of richneſs, as where they have been made by lean ſtock with a large proportion of litter. On turning over heaps of this kind, about a ton of oil cake ſhould be well and evenly mixed with every twenty or thirty tons of the dunghill compoſt: by this practice a rich and good manure is ſaid to be formed. The ſucceſs of theſe ſubſtances, when made uſe of alone as manures, has been found to depend, in a great meaſure, upon the falling of rain ſoon after they have been put upon the land, as in dry ſeaſons little benefit has been derived from their application. The reaſon of this ſeems to be, that as the cake when uſed is moſtly in an extremely hard and dry ſtate, it does not undergo that decompoſition which is neceſſary, until it has been moiſtened by the rain, by which it is rendered capable of running quickly into the ſtate of putrefaction, and conſequently of affording ſuch matters as are ſuitable for the ſupport of plants. When applied without being incorporated with other ſubſtances, it is moſtly laid on to the amount of four or five quarters to the acre, according to the condition of the land.

The refuſe or pulp of pears and apples, which have been ground, and the liquor ſqueezed from them, may likewiſe be converted to the purpoſe of a manure in the cyder diſtricts. When employed in this way, however, ſome heavy ſubſtance, ſuch as good earth with a little dung, ſhould probably be mixed with it before it is put upon the ſoil, as by being blended with ſuch materials it may be more conveniently and more extenſively applied.

MANURES FROM THE *AGENCY* AND *DECOMPOSITION* OF *FOSSIL SUBSTANCES.*

SUBSTANCES of the calcareous kind, which are to be conſidered under this head, produce effects more or leſs powerful in promoting the growth of vegetable crops, in ſome meaſure, according to the ſtate and quantity in which they are applied, the nature of the ſoils on which they are employed, and the properties of the matters with which they are combined. For though calcareous materials have been made uſe of as manures for a very great length of time, and been applied in various ways, difficulties ſtill remain concerning the manner of their

operation, in many caſes, which ſeem principally, however, to proceed from the want of proper diſcrimination in reſpect to the ſtate of the different calcareous ſubſtances at the time of their application, and their being made uſe of to different ſoils, without a ſufficient diſtinction of the properties of the materials of which they are conſtituted or compoſed. There is likewiſe another circumſtance, which the ingenious experimental enquiries of a late author * have ſhewn to be neceſſary to attend to, which is, the ſubſtances the calcareous material is combined with; as he has found that where magneſia is in union with the calcareous matter, it is not by any means ſo beneficial for the purpoſes of manure and promoting vegetation, as where no ſuch mixture or combination is preſent, eſpecially when uſed in the ſame proportions. From ſand entering largely into the compoſition of lime-ſtone or other calcareous matter, in ſome caſes, as it is a ſubſtance of much greater ſpecific gravity than pure cauſtic lime, conſiderable differences in its effects as a manure may likewiſe be produced †.

On all theſe accounts, therefore, though lime may be produced from chalk, marble, different lime-ſtones, coral, and ſhells, by ſubjecting them to ſuch degrees of heat as is neceſſary to expel or diſengage the carbonic acid or fixed air that they contain, which is apparently of the ſame quality, it may vary in its effects when employed in agriculture.

Lime, when newly burned, or before it becomes loaded or ſaturated with the moiſture and carbonic acid, or fixed air, contained in the atmoſphere, which, from their ſtrong tendencies to combine or unite with it, generally ſoon takes place, is, in its moſt active ſtate, and from the power which it poſſeſſes of breaking down and deſtroying the texture and organiſation of ſuch animal and vegetable ſubſtances as come in contact with it, is termed *cauſtic* or *quick* lime. When applied, under theſe circumſtances, to grounds which abound either with freſh vegetable matters, or ſuch as have undergone ſome degree of change by being buried in the ſoil, as in moory and heathy mountain land, peaty or boggy earth, and all ſuch ſoils as have long remained in their original uncultivated ſtate, covered with a variety of coarſe plants, it is found to produce beneficial effects; in the firſt caſe probably by its ready action on the different materials of the green plants, by which it diſengages from them hydrogen and azote, from the ſubſequent combination of which, ammonia or volatile alkali is produced, a

* Tenant, in Philoſophical Tranſactions. † See Anderſon's Eſſays, vol. I. p. 511.

ſubſtance which has great power in promoting vegetation, as is evinced in caſes where ſubſtances that contain this matter in large quantities are uſed as manures; and, in the ſecond place, by its combination with the carbonaceous matter of ſuch ſoils, or with that of the various animal and vegetable matters which are contained in them, in ſome of the ſtages of their putrefaction or decay, and by this means rendering it ſoluble in water, and thereby capable of being taken up as food by the abſorbent roots of vegetables *; and, though lime in its pure or cauſtic ſtate retards, in ſome degree, the proceſs of putrefaction, eſpecially when uſed in any large quantity, it is probable, that by its power of corroding and diſſolving the hard and fibrous parts of vegetable and other matters, as is ſhewn by its quickly reducing the ligneous particles of bark, which has been employed in the proceſs of tanning, to the ſtate of mould, it may bring the abundant vegetable and other materials contained in ſuch ſorts of land quickly into that earthy condition in which they afford the nouriſhment and ſupport of crops, which by the proceſſes of putrefaction, and inſect digeſtion, could only have been performed in a very ſlow and gradual manner.

Pure lime too, from its well-known property of deſtroying different kinds of inſects, ſuch as worms, ſnails, ſlugs, grubs, &c. which are moſtly abundant in rich freſh ſoils, may furniſh much nutritious matter for the purpoſe of vegetation.

And from its having a greater tendency to combine with mucilaginous oily matters than with fixed alkalies †, a kind of calcareous ſoap may in ſome caſes be formed, that may contribute, in its liquid ſtate, to the nouriſhment of plants.

When pure lime is mixed with clayey ſoils which do not poſſeſs too great a degree of humidity, it is likewiſe capable of rendering them leſs ſtiff and tenacious, conſequently more ſuitable for admitting the ſmall fibrous roots of vegetables, not only by the evolution of heat and other elaſtic matters, during the period of its becoming ſaturated with the moiſture and fixed air, or carbonic acid, which they may contain, but alſo by being thereby moſt intimately and minutely mixed with them, from the fine impalpable powdery ſtate to which it is neceſſarily reduced. Where, in ſuch ſoils, the ſulphuric acid abounds, it may likewiſe produce good effects, by forming with it a kind of gypſeous compound, and where other acids are preſent that are prejudicial to vegetation, by the power which it poſſeſſes of neutraliſing them.

* Darwin's Phytologia, p. 203. † Nicholſon's Philoſophical Journal, vol. I. p. 170.

And where the lime has been burnt from the magneſian lime-ſtone, it may probably be ſerviceable when applied to clayey or other ſoils that contain the ſulphuric acid, which are uſually denominated ſour lands by farmers, by forming a ſort of Epſom ſalt in the ground, a ſubſtance which the experiments of Dr. Home have long ſince ſhewn to be highly favourable to vegetation when uſed in ſmall quantities.

Lime, on expoſure to the atmoſphere for ſome time, undergoes a conſiderable change, being rendered mild by the abſorption of carbonic acid or fixed air from it. In this ſtate of combination it is termed, by modern chemiſts, *carbonat of lime*, or *effete* lime; its power or capability of acting upon, and deſtroying or breaking down, the texture of organiſed bodies, being greatly diminiſhed. It ſtill, however, promotes their diſſolution and decay, by aiding and forwarding the natural proceſs of putrefaction, as is ſufficiently proved by thoſe compoſt dung-heaps with which it has been mixed becoming much more quickly in the ſtate to be applied to land than where no ſuch ingredient had been employed; by this means it therefore contributes greatly to the ſupport of vegetation: and it has been lately obſerved, that where incorporated or blended with ſuch compoſts of ſoil and manure, as are in the ſtate of generating nitrous acid, it arreſts the acid as it forms, by which means a calcareous nitre is produced, and thus the exhalation and ready eſcape of a nutritious material is guarded againſt and prevented *.

The combination of lime with carbonic acid, by rendering it ſoluble in water in its fluid ſtate, without being expanded into gas or vapour, may likewiſe ſupply much carbonaceous matter for the ſupport of vegetation, as has been ingeniouſly conceived by the ſame author. The property poſſeſſed by lime, of ſuperſaturating or overloading itſelf with moiſture, attracting or drawing it away from the air in contact with the ſurface of the ground and the earth underneath, and after depriving them of it and the carbonic acid which they contained, permitting them to eſcape again, as has long been obſerved in the caſe of new-plaſtered walls, may alſo be of conſiderable utility when it is applied to the more dry and ſandy ſorts of ſoil, by affording moiſture and ſuch aërial matter to the roots of the vegetable crops; which it is capable of ſupplying in a very equal and extenſive manner, from the extreme ſtate of pulveriſation to which it is frequently reduced when ſlaked by the dampneſs of the atmoſphere, or very gentle rains.

Beſides theſe modes of promoting the growth of vegetable crops, it has been

* See Darwin's Phytologia, p. 218.

ſuppoſed that calcareous earth, by containing phoſphorus, may alſo be uſeful, as by its union with it, a kind of hepar may be produced, and the phoſphorus thereby rendered ſoluble in water, without becoming an acid by means of its combination with oxygen or vital air *. Phoſphorus he conceives to be probably as neceſſary an ingredient in vegetable as in animal bodies, as is evident, he thinks, from the phoſphoric light ſeen on rotten wood, in ſome of the ſtages of putrefaction; in which, he imagines, the phoſphorus is ſet at liberty from the calcareous earth, or from the fixed alkali, or the carbon of the decompoſing wood, and acquires oxygen from the atmoſphere, both warmth and light being omitted during their union. And it may, he further obſerves, perhaps more frequently exiſt in the form of phoſphoric acid in vegetables, and be thus readily combined with their calcareous earth, and may be ſeparated from its acid by the carbon of the vegetable during the time of calcination, and alſo in the proceſs of putrefaction.

This view of the nature and properties of lime ſhew that it may be employed, in one or other of its forms, more generally to ſoils than has been ſuppoſed by agricultural writers. It ſhould, however, never be made uſe of without duly attending to the nature and conſtitution of the ſoil on which it is to be applied, as upon this circumſtance its ſucceſs will, in a great meaſure, depend; and it is, perhaps, only by it that the proportion, the ſtate, and the manner of its application, can be advantageouſly directed.

It is evident, from the various trials that have been made, by practical farmers, that the more intimately and the more minutely lime is blended and incorporated with the ſoils on which it is applied, the more full and complete are the effects which it has in ſupporting the growth of different ſorts of crops. Thus it has been remarked by a very intelligent writer, that "if a heap of lime of a conſiderable thickneſs ſhall have been ever ſo long on one ſpot, and be afterwards carried clean away from it, ſo that none of the particles of the lime remain to be mixed with the ſoil, that ſpot will not be richer, or carry more luxuriant crops, than the places around it; which, every one knows, is not the caſe with regard to dung." And again; that "if lime be ſpread upon the ſurface of the ſoil, and allowed to remain there without being ploughed in, its effects will ſcarcely be perceived for ſeveral years, till it has had time gradually to ſink through the ſward, and mix with the ſoil; after which its effects begin to be perceived, although much leſs ſenſibly than if the ſame quantity of lime had been intimately mixed with the ſoil by means of the

* See Darwin's Phytologia, p. 215.

plough and harrow." He obſerves, that he is not a ſtranger to the improvements that have been made in Derbyſhire by means of lime, without the plough; but this is no exception, he thinks, to what he has ſaid. The effects are ſlow, though certain. Thoſe who inhabit countries that admit of the plough, are often, he ſays, adviſed to lay lime upon the graſs, and are made to believe that their paſture will be inſtantly mended by it, nearly in the ſame perceptible manner as if it had been dunged. This he has tried, and has ſeen it tried by others; but always found that the graſs for the firſt year was rather hurt than benefited by it; nor was it ſo much improved in ſucceeding years, as if the ſame quantity of lime had been applied, and intimately mixed with the ſoil. In this mode of applying lime, it is long, he thinks, before it yields a proper return; and is not to be recommended to a poor man, unleſs where neceſſity obliges him to practiſe it *.

On theſe grounds it is likewiſe conceived, that lime may be employed much more advantageouſly when made uſe of, even in ſmall proportions, than ſuch calcareous ſubſtances as have been reduced into the ſtate of powder without calcination. It is well remarked, however, by the ſame author, that much muſt depend on the mode in which the lime is applied. "If," ſays he, "it is ſpread as ſoon as it is ſlaked, while yet in a powdery ſtate, a very ſmall quantity may be made to cover the whole ſurface of the ground, and to touch an exceedingly great number of particles of earth; but if it is ſuffered to lie for ſome time after ſlaking, and to get ſo much moiſture as to make it run into clods, or cake into large lumps, it can never be again divided into ſuch ſmall parts; and therefore a much greater quantity is neceſſary to produce the ſame effect, than if it had been applied in its powdery ſtate. But if the ſoil is afterwards to be continued long in tillage (as theſe clods are annually broken ſmaller by the action of the plough and harrows), the lime muſt continue to exert its influence anew upon the ſoil for a great courſe of years; it will produce an effect nearly ſimilar to that which would be experienced by annually ſtrewing a ſmall quantity of powdered lime over the whole ſurface of the ſoil: but as the price of the lime muſt, in the firſt caſe, be paid by the farmer altogether at the beginning, which only comes to be ſucceſſively demanded in the other caſe, this deſerves to be attended to, as it may become a conſideration of ſome importance where lime is dear, and money not very plentiful."

There is another circumſtance that requires to be conſidered in reſpect to the

* Anderſon's Eſſays, vol. I. p. 523.

application of lime, which is, the quantity that may be neceſſary to be employed. The opinions of practical writers are much at variance in regard to this point, ſome contending that a ſmall quantity can only be applied with ſafety and advantage, while others maintain that ſcarcely too great a proportion can be made uſe of. It is obvious, however, from the differences that take place in ſoils, that no particular proportion can be ſuitable in every caſe, but that it muſt be varied very conſiderably according to the circumſtances that have been already ſtated, as well as from the ſituation or condition of the land on which it is laid, and the proportion of *real* calcareous matter that may be contained in the lime that is to be applied. As it has been ſhewn that lime, when in its moſt active ſtate, ſoon becomes reduced ſo as to be perfectly mild by its property of abſorbing moiſture, and the carbonic acid from the air, there can be little danger of injury from its cauſtic quality, though it may, on its firſt application, have a tendency to unite with and deſtroy ſuch green or other vegetable productions as may be preſent.

It is remarked, however, by a late practical writer, that "moſt kinds of *ſtone-lime* ſhould be applied with a ſparing hand, and with a conſiderable degree of caution, as the *cauſtic* quality is many times greater in *this* than in lime made from chalk." He has had many opportunities, he aſſerts, of ſeeing total barrenneſs induced by *a too liberal uſe of it*; very generally at the ſeveral places where the carts were ſtopped for the men to ſpread it; at the bottoms of every heap; and once an entire cloſe *.

It has been employed in different proportions, from one to ſix or ſeven hundred buſhels on the acre, on various ſorts of ſoil, by ſome very accurate agricultors, under ſimilar circumſtances, with benefits in proportion to the quantities applied in augmenting the fertility of the ſoil. And accidental experiments have demonſtrated that it may be uſed in ſtill larger proportions with advantageous effects †. In ſhort, it is concluded by this writer, that, "on ſoils which do not naturally abound with chalk, or other calcareous matter, there is leſs danger in giving too much lime, than in applying too little, except in thoſe caſes where an over-luxuriance is dreaded."

It has been aſſerted, that lime never contributes to increaſe the fertility of ſoils, but that it has detereorated them greatly by promoting their over-ex-

* Middleton's View of the Agriculture of Middleſex, p. 308.

† See Anderſon's Eſſays, vol. I. p. 529.

hauſtion *. This ſeems, however, difficult to explain, when the nature of its properties are fully conſidered; and it is more probable that ſuch an effect may have proceeded from injudicious cropping, and improper cultivation, than the operation of the manure, eſpecially as it has been employed in many well-cultived diſtricts very extenſively, and for a great length of time, without any diſadvantage of ſuch a nature having been experienced †.

The duration of the beneficial conſequences of the uſe of lime in promoting the growth of vegetable crops muſt be different, according to the differences of circumſtances in the land to which it is applied; the proportion of it that is employed, the kind of crop that is cultivated, and a variety of other cauſes of the ſame nature. But it is evident from the facts that have been ſtated by practical writers, in reſpect to its continued powers of prediſpoſing lands on which it has been laid to the growth of particular ſorts of crops in preference to others; of rendering the operation of other kinds of manure, and other methods of culture, more effectual than where it has never been uſed; that it muſt produce very uſeful permanent changes in the ſoils to which it is applied ‡. An additional proof of this is likewiſe met with in the well-known circumſtance of the quality of the grain from ſuch lands as have been limed being much improved, having a thinner ſkin, and yielding much more flour than from ground where it has never been made uſe of; which is ingeniouſly ſuppoſed, by an able author, to proceed from its containing more ſtarch and leſs mucilage, on account of the tendency of the lime to promote the converſion of the latter ſubſtance into the former, by haſtening the ripening of the ſeed §.

This alſo ſhews the importance of this ſort of manure in thoſe kinds of land that are late in bringing their grain crops to perfection, whether from their particular nature, or the ſituations in which they are placed.

Lime has been ſometimes objected to as a manure for tillage lands by agricultors, on account of its ſuppoſed tendency to ſink down in the ſoil below the reach of the plough, and thereby becoming of no utility. This can probably, however, only be the caſe where the lime has not been ſufficiently burnt, or afterwards, on its application, properly reduced into the powdery ſtate, and ſpread out equally over the land; as where theſe points have been well attended to, from its having conſiderably leſs ſpecific gravity than moſt ſoils, no ſuch conſequence can take

* Middleton's View of the Agriculture of Middleſex, p. 309.
† Anderſon's Eſſays, vol. I. p. 532.
‡ Ibid, p. 534.
§ Darwin's Phytologia, p. 220.

place; the fine particles of the lime, from their being ſo very minutely intermixed and blended with the earthy materials, not having any diſpoſition to ſink down through the ſuperficial ſtratum of mould: but when applied in a coarſer and leſs reduced ſtate, from its dry quality, and that of its not intimately combining with the particles of the ſoil in the way of animal or vegetable manures, it may occaſionally fall down, when collected on the ſurface, during the time of reiterated ploughing, or otherwiſe ſtirring the ground, and reſt upon the more ſtiff and firm ſubſoil below the track of the plough.

On theſe accounts it may, therefore, be neceſſary, in the application of lime, to pay greater attention than uſual, not only to the preparation, but likewiſe the reduction of it into the moſt perfect powdery ſtate, as well as the ſpreading it out over the land with the greateſt equality when dry and free from lumpineſs. It may alſo be of advantage where it has been laid on the ſurface of land, eſpecially the graſs kind, to plough the firſt time after ſuch application with but a light furrow, as by this means the portion that may fall down in the way mentioned above, will not merely be prevented from getting to ſuch a depth as may render it uſeleſs, but be more intimately incorporated with the ſoil by ſubſequent ploughings *.

It is probable that the differences in the modes of applying this ſubſtance to ſtiff adheſive ſoils, may have cauſed the great diverſity in its effects which have been ſo frequently noticed by practical writers.

As we have ſeen that there are conſiderable differences in reſpect to the purity or goodneſs of lime-ſtone, or other calcareous matters, it is obvious that there muſt be much variety in regard to the lime that is produced from them. Where it has been prepared from the purer kinds, when brought into the ſtate of powder by being ſaturated with water, it is perfectly ſoft, ſmooth, and impalpable; while in other caſes it feels coarſe and gritty, according to the different degrees of impurity. In general, ſo far as the purpoſes of agriculture are concerned, that lime which has the greateſt levity, is the ſofteſt and ſmootheſt to the touch, and has the whiteſt colour, is the moſt advantageous †.

* See Anderſon's Eſſays, vol. I. p. 537.

† The following criteria and analyſis have been offered by Doctor Anderſon, in his Eſſays, vol. i. p. 514, in order to judge of the goodneſs of lime: "If," ſays he, "the lime-ſtone loſes much of its weight in calcination, and the lime-ſhells are extremely light; if the ſhells require a very large proportion of water to ſlake them fully; if it is long before they begin to fall; if the lime-ſtone is not apt to *run* (or be vitrified) in the operation of burning; if it falls entirely when it gets a ſufficient quantity of water, after it has been properly calcined; if it ſwells very much in ſlaking; and if the lime is light, fine to the

In the carriage of lime for the uſes of the farmer, it may ſometimes be neceſſary, where the diſtance is conſiderable, to pay attention to the nature or ſtate of it, as without that much expence may be incurred to no purpoſe. When the lime is pure, it will be the moſt economical method to convey it in the ſtate of ſhell, as by that means nothing will be carried but what is uſeful; whereas, if it was carted in a ſlaked condition, a large proportion of water, and other matters, muſt be conveyed with it. But where lime is impure, and adulterated with other ſubſtances, or imperfectly prepared, it may be a more ſaving method

touch, and of a pure white, the farmer may be ſatisfied that it is extremely good, and may uſe it in preference to any other lime that is inferior to it in any of theſe reſpects. Theſe rules are, he thinks, perfectly ſufficient to decide as to the comparative value of any two kinds of lime that may be oppoſed to one another, and may be relied upon as ſufficiently accurate for the ordinary purpoſes of the farmer. But that ſuch as may diſcover a new quarry of lime-ſtone, and who wiſh to aſcertain with certainty its real value, before they put themſelves to any expence about it, will do well to employ the following more accurate, and, in that caſe, more eaſy analyſis. As all calcareous matters are capable of being diſſolved in acids, and as no other earthy matter can be diſſolved in them, it follows, that if a ſufficient quantity of acid is poured upon any body that contains calcareous matter, this matter will be quickly diſſolved, while the others are left behind; and the proportions of each may be accurately aſcertained. To try the exact value of any kind of lime-ſtone, or other calcareous matter, take a quantity of aqua fortis, or nitrous acid, or ſpirit of ſalt, or muriatic acid. It may be obſerved, that all the mineral acids effervеſce and unite with calcareous earths. But as the ſulphuric or vitriolic acid (ſpirit or oil of vitriol) does not *diſſolve* the calcareous matter, but forms a new concrete that ſtill retains its ſolid ſtate, it is not fit for this experiment. And as it ſometimes happens that a little vitriolic acid is mixed with either the nitrous or muriatic acids, it becomes neceſſary to be certain that this is not the caſe before they are employed in this experiment. The eaſieſt way of trying if theſe acids are free from the vitriolic, is to put a little chalk into them before you employ them. If the acid is pure, the chalk will diſſolve very readily; but if not, ſome part of the chalk will fall to the bottom, in the form of a pure white ſediment. When this is the caſe, add ſmall bits of chalk, by little and little, till no more of that white ſediment appears; after which, the acid may be kept for uſe, as ſufficiently pure. If the nitrous acid is ſo ſtrong as to have a ſlight brown or reddiſh appearance, it ought to be diluted with water till it aſſumes a greeniſh look. As it is bought in the ſhops, for the uſe of dyers, &c. it is uſually weak enough. If the muriatic acid is ſo ſtrong as to have a bright yellow colour, or emits fumes when the bottle is opened, it ought to be diluted by adding water, till it aſſumes almoſt a colourleſs tranſparency, with a very faint tinge of yellow. When they are thus prepared (either of theſe acids may be uſed indiſcriminately for this experiment, as they are equally proper), put them into a glaſs or earthen veſſel; add to that, by little and little, a known quantity of the matter you mean to examine, which had been previouſly dried and reduced to powder. After each addition, ſuffer the violent effervеſcence or ebullition that will enſue, to abate before more is added. When the whole of the powder is put to the acid, and the effervеſcence entirely ſubſided, ſtir it about ſeveral times with a piece of tobacco-pipe, and allow it to remain for ſome time, that the acid may act upon every particle of the matter, and thoroughly diſſolve it: and to be certain that there has not been too little acid, put a few drops of freſh acid to the ſolution, which will excite a freſh effervеſcence if the

to carry it in the ſtate of powder; otherwiſe much matter may be conveyed that will never ſlake or fall down into lime*.

Lime may be employed in many different kinds of ſoil with advantage, when proper attention is paid in its application; but in its more active ſtates it has been ſhewn, by experience, to be the moſt uſeful on thoſe moory, peaty, heathy, and other ſoils which contain a large portion of coarſe vegetable matter.

From what has been obſerved, it ſeems probable that lime, beſides exerting its influence, when united with ſoils, in reducing the materials which they contain into the ſtate or condition ſuitable for affording the nouriſhment of plants, and rendering them more proper for their reception, by altering their

whole is not fully diſſolved. When no change is produced by this addition, it is a certain proof that the whole of the calcareous matter is already diſſolved. Take then a piece of filtering-paper, thoroughly dry, the weight of which is alſo known; fold it properly, and put it in a glaſs funnel; pour the whole of the ſolution, with the matter that may have ſubſided, into the funnel, and allow it to filtre through the paper ſlowly. When the fluid part has thus drained off, fill up the filtre again with pure water, to waſh off the whole of the ſaline parts from the *reſiduum*, or matter that remains undiſſolved. Add water in this manner till it comes off without any ſaline taſte,—ſuffer it then to drop off entirely,—dry it thoroughly,—and weigh the paper with its contents. The difference between which, and what the powder and paper were at the beginning, is the whole weight of the calcareous matter, ſo that its proportion to the whole maſs is perfectly aſcertained."

In this manner, he ſays, he has examined a great many different kinds of lime-ſtone, and has found them vary in all degrees of purity from ſuch as were entirely ſoluble in acids, as ſugar or ſalt is in water, to others that contained only one-twelfth of their weight of ſoluble matter, and eleven-twelfths of ſand. The ordinary kinds of lime-ſtone contain from one-third to two-thirds of their weight of ſand. Hard chalk is uſually a pure calcareous earth, ſoluble in acids; and ſome ſorts of lime-ſtone may be met with that are equally pure, but theſe are rare. Were all the ſtones in the ſame quarry equally pure, the above would, ſays he, be a perfect and unexceptionable method of aſcertaining the purity of any lime-ſtone; but it often happens, that in a quarry of the very worſt quality, there are ſome pieces found that conſiſt of pure ſpar, that are entirely free of any mixture of ſand; and in other quarries of a better ſort, there are often ſmall veins of an impure ſort of ſtone, mixed through the rock; ſo that if either of theſe ſhould chance to be picked out as a ſpecimen for trial, the reſult would not be juſt. To avoid falling into this miſtake, any one who wiſhes to make an accurate analyſis of any newly-diſcovered lime-ſtone will do well, he ſays, to take eight or ten ſtones from different parts of the quarry, that are ſomewhat different in appearance from one another; and, having taken a chip from each, pound the whole together, to afford a proper ſubject for the experiment. The ſame experiment might be tried with *lime*; but it is evident the proportions would be different in the ſame ſtone, from what they would be if tried before calcination, as lime wants its fixed air, &c. which it had when in the ſtate of lime-ſtone. But as the lime is more liable to be varied by accidental circumſtances, it is beſt to try the experiment with lime-ſtone.

* See Anderſon's Eſſays, vol. I. p. 509.

textures, or removing ſuch quálities as are noxious, is capable of ſupplying ſuch matters as contribute to their growth and ſupport. On this account it probably is, that it has been found by experience to be equally, if not more beneficial, on poor than on rich ſoils; and its requiring to be mixed and incorporated with but a ſmall portion of earth or mould, to render it highly productive.

Lime-ſtone, and other hard calcareous ſubſtances, without being ſubjected to the proceſs of calcination by heat, may, in many caſes, as where fuel cannot be procured to burn it into lime, be beneficially employed for the amelioration of land, as has been ſhewn by the experiments of Monſ. Du Hamel, and others. When thus uſed it ſhould be well pulveriſed, by ſuch mechanical means as can be cheaply performed; much of the advantage to be derived from it probably depending upon its being reduced into a conſiderable ſtate of fineneſs, by which it may be more minutely blended with the ſoils on which it is applied, and thereby act upon and afford nutritious principles more extenſively for the ſupport of crops; and at the ſame time render the heavy and more coheſive ſoils lighter, by being more uniformly incorporated with their clayey and earthy materials*. But as calcareous ſubſtances can never be reduced, by any ſort of machinery, to the fine powdery ſtate which they are capable of being carried by means of calcination,

* It is obſerved by Dr. Anderſon, in his Eſſays, vol. I. p. 503, that he has ſeen the model of a mill that had been invented for this purpoſe, which was conſtructed on the ſame principles with an ordinary gunpowder-mill. It had ſeveral large maſſy ſtampers, compoſed of huge blocks of caſt-iron, that were ſucceſſively lifted up and let fall by a wheel that catched their handles, and, after a proper time, ſlipped them again as it revolved round its axis. Theſe ſtampers fell with great force upon the lime-ſtone that had been previouſly broken into pieces of a moderate ſize, and placed in a ſtrong trough formed for that purpoſe. Through this trough a ſmall ſtream of water was conveyed, which waſhed away with it the ſmall pieces of lime-ſtone, as they were ſucceſſively reduced to powder by the ſtampers. This ſtream of water was received into a large reſervoir, in which it was allowed to ſtagnate, and depoſit as a ſediment the lime-ſtone powder it brought along with it; the pure water flowing gently over a part of the brim, which was made lower for that purpoſe. When the reſervoir was nearly full of this fine powder, the work was ſtopped; the water was drawn off from the reſervoir, by taking out ſome plugs left for that purpoſe, at different heights, till all that was clear had run off: the powdered ſtone was afterwards thrown out to the bank, and allowed to dry ſufficiently for uſe. He has, he ſays, alſo heard that a mill, upon theſe principles, was erected by the Honourable the Truſtees for managing the forfeited eſtates in Scotland, and that a good deal of lime-ſtone was pounded with it; but as it was erected in the Highlands of Scotland, where roads were bad, and where there was but little ſpirit for improvements in agriculture, as there was no public demand for the manure, after the experiment was ſufficiently tried to ſhew that it might be practiſed with advantage in other places, the mill was ſuffered to lie unemployed.

it is probable that, when employed upon land, they will be leſs beneficial in many caſes, than when uſed in the ſtate of lime. It is on the above principles too, moſt probably, that the ſcrapings of roads, made with calcareous and other ſubſtances, are found ſo beneficial in different inſtances, a large portion of them being in the ſtate of an extremely fine powder, from the attrition of the wheels of carriages, and other cauſes.

The experiments of Mr. Tennant, which have been already noticed, ſuggeſt, that even where magneſian lime-ſtone is made uſe of in this ſtate of reduction, without being converted into lime, it may not be ſo friendly to vegetation as that which is perfectly calcareous, eſpecially when employed in the ſame proportions; a circumſtance which may, in ſome degree, account for the difference which has been obſerved in the utility of ſuch ſubſtances as manures. Such lime-ſtones as contain the largeſt proportions of argillaceous earth in their compoſitions, when employed in this reduced ſtate, will be the moſt proper for the thin light ſoils; as by that means the ſtaple of them may be increaſed to the great advantage of the crops. In the application of this ſort of material to land, the farmer ſhould conſtantly be attentive to the ſtate or condition to which it is reduced, as well as the nature of the ſoil, and put it on in ſuch proportions as may be moſt ſuitable to them.

Lime-ſtone gravel, a ſubſtance which has been ſucceſsfully laid upon land in Ireland, and which is a kind of ſtony marle, might moſt probably be equally or more beneficial, in conſiderably leſs quantities, if the ſtony lumps which it contains were firſt more perfectly reduced; for it has been remarked, that where the pieces are large, a much greater proportion is required, and the effects are ſlower than where they are ſmall.

Chalk is another material of the calcareous kind, which is capable of producing good effects on land, when applied in a ſuitable manner in its uncalcined ſtate. From its having a portion of argillaceous or clayey matter united with it in ſome caſes, it partakes of the nature of marle. Where it is made uſe of to the more ſtiff, clayey, loamy, and heavy ſorts of ſoil, it ſhould, in moſt caſes, be as much pulverized and reduced as poſſible before it is laid on, in order that it may be ſpread with greater exactneſs, and be more regularly mixed and blended with the ſtiff and compact materials of ſuch lands; from which they may be rendered more capable of admitting the fibrous roots of vegetable crops to ſpread themſelves in them, and thereby take in more perfectly the nutritious matters which are preſented to them. That this practice is of much utility and advantage, is evident from the circumſtance of farmers, in moſt of the diſtricts where chalk is

employed as a manure, finding that it is conſiderably more beneficial when made uſe of in the ſpring, after having been dug up in the autumn, and expoſed to the froſt and moiſture through the following winter, and by that means much pulveriſed and broken down, as well as by their carefully breaking and reducing the larger pieces. It would probably, however, be a ſtill more advantageous practice to break it down, and apply it as quickly as poſſible, after digging it out of the pit; as by leaving it expoſed to the atmoſphere for ſome length of time, it not only becomes hard, but likewiſe leſs ſoluble, and therefore leſs proper for the purpoſes of manure. Hence it probably is, that farmers, where the chalk huſbandry is practiſed, find the dreſſings more efficacious when the chalk is dug from a conſiderable depth, than where it lies near the ſurface of the ground. In the dry and light ſoils too it may, probably, be more ſerviceable in this reduced and powdery ſtate, from the circumſtance of its poſſeſſing more moiſture, on account of a more extended ſurface being expoſed to the air, and the particles of the ſoil, from which it may abſorb and attract it, and afterwards part with or afford it in a more regular and uniform manner to the abſorbent roots of the growing vegetable crops. The obſervations of practical farmers, however, invariably ſhew, that on ſuch ſoils it is much more beneficial when made uſe of in the form of compoſt, either with rich peat or vegetable earth and mould, or with good dung; as by this means a great defect in ſuch kinds of land, the want of well reduced vegetable matter, is remedied, and a greater proportion of nutritious materials afforded for the ſupport of crops.

When this manure is employed upon the more wet and poachy kinds of ground, there is probably not the ſame neceſſity for its being reduced to a great degree of fineneſs, as it may be apt, under ſuch circumſtances, to diſſolve, and ſink down too much by being ſo greatly diluted with water, while in the rounder ſtate it may be retained nearer the ſurface, and thereby be capable of abſorbing and taking away the ſuperabundant ſurface moiſture more effectually. But even in ſuch ſoils, where the principal intention is the deſtruction of moſs, ruſhes, and other coarſe plants, the growth of which depends upon a great degree of ſuperficial wetneſs, it may be employed moſt advantageouſly in a ſtate of conſiderable reduction, as from its greater readineſs to ſink down, it may the more quickly take away from their roots the exceſſive moiſture that ſupports them. It may, perhaps, neutraliſe acids too, when they exiſt under certain combinations in theſe ſoils, more readily when applied in its comminuted or pulveriſed ſtate than in the lumpy one in which it is commonly uſed.

The proportion in which this ſubſtance is to be applied to the ground muſt depend, in a great meaſure, upon the ſtate of the ſoil, the nature of the crop,

and the purpoſe for which it is employed. In many of the ſouthern counties it is laid on the ſtiff clayey ſoils in large quantities, as from twelve to fourteen or fifteen waggon loads, of from fifteen to twenty hundred weight each, to the acre; and on the ſandy ſoils in ſome parts of Kent, at the rate of one hundred and ſixty buſhels to the acre.

On the deep and ſtronger kinds of ſoil, the practice is commonly either to lay it on the clover leys while feeding off, or upon the ſummer fallows. And in the form of compoſt it is frequently uſed on the light ſoils, both to the fallows for wheat, and the graſs lands.

As chalk cannot, by any means, be reduced to that ſtate of powdery fineneſs that is the caſe with lime, and conſequently cannot be ſo equally ſpread out, or ſo minutely blended with the ſoil, it is evident that much larger proportions of it muſt be employed to produce the ſame effects on the ſoil; perhaps ſeldom leſs than three or four times the quantity will be required.

Where chalk muſt be carried from a great diſtance in its wet, heavy ſtate, it will generally be the moſt economical practice to have it firſt converted into lime.

Marle is a calcareous ſubſtance, found under very different forms, and in different places, and made uſe of as a manure with much advantage, both on the thin light ſoils, and ſuch as are more heavy and compact. It is diſtinguiſhed, from its particular appearances, into *ſhell*, *clay*, and *ſtone* marle. The firſt is evidently of animal origin, from its being compoſed of teſtaceous or ſhelly matters, in greater or leſs degrees of attenuation, from the gradual decompoſition which they have undergone during the ſucceſſion of ages, with a ſmall portion of earthy ſubſtances mixed and blended with them. It is conſtantly found in ſuch ſituations as have been covered with water, from which, as the ſediments or depoſitions of mud or other earthy materials, in ſuch caſes, muſt have been different from various cauſes, ſuch marles muſt be more or leſs pure, or contain greater or leſs proportions of calcareous matter, according to ſuch circumſtances; in general, however, they contain a larger proportion than the ordinary ſorts of lime.

In the ſecond kind there is much clay uſually combined with the calcareous matter, from which circumſtance it abſorbs and retains moiſture more ſtrongly than moſt of the other kinds. The clayey ſorts of marle vary greatly in reſpect to their colours, being met with both of a brown, blue, red, and yellow tinge; and the ſtone marle has different proportions of ſand united with the calcareous matter and the clay, upon which depends the differences in regard to its hardneſs. Where this ſort of marle has a thin laminated ſtructure and flakey appearance, it is frequently denominated *ſlate marle*. From the portion of

clay that is contained in theſe marles, they become capable of being gradually ſoftened by the action of water, and ultimately fall down into the powdery ſtate. All marles contain ſome portion or other of clay, in combination with the calcareous matter, as has been long ſince ſhewn *, while in lime it is moſtly ſand which is united with that ſubſtance †.

But notwithſtanding theſe differences in the appearance and conſtitution of marles, they all agree in being reduced into a pulverulent or powdery ſtate, by expoſure for ſome length of time to the influence of the atmoſphere, by which means they are rendered ultimately capable of being intimately blended with the different materials of the ſoils upon which they are applied: but as this general property of falling down into ſmall particles, in conſequence of the abſorption of moiſture and carbonic acid, or fixed air, from the ſurrounding atmoſphere, is much greater in ſome kinds of marle than others, it may cauſe ſome difference in their utility as manures. Where ſubſtances of this kind are laid upon land, for the purpoſe of ſupporting an immediate crop of either corn or graſs, there can be little doubt but that the moſt crumbly, or thoſe the moſt readily reducible into a powdery ſtate, are the moſt proper; but where they are laid on with the intention only of aſſiſting future crops, or of producing more laſting effects, thoſe that are more hard, and leſs diſpoſed to fall into pieces, may be more advantageouſly employed. The former ſeems to be ſhewn to be the caſe, by the common obſervation of practical huſbandmen in marling diſtricts, that marle does not exert its full effects on the ſoil, until it has been well mixed and incorporated with it by frequent aration, and by the practice of letting it remain ſome time on the ſurface of the ground, before it is turned down, from which it becomes much pulveriſed and reduced; and

* Ainſlie in Phyſical and Literary Eſſays, Edinburgh, vol. III.

† It is uſefully remarked by Doctor Wilkinſon, on the authority of the late able Profeſſor of Chemiſtry at Edinburgh, in the twenty-firſt volume of the Annals of Agriculture, that as all marles effervesce, or raiſe up frothy bubbles, when acids are applied to them, and as water alone frequently produces the ſame effects when poured on dry clay, it may be neceſſary, in order to guard againſt miſtake in making trials upon ſubſtances ſuſpected to be marles, to let them remain a little time in mixture with water previous to their being ſubjected to the teſt of acids. The beſt or richeſt marles being ſuch as contain the largeſt proportion of calcareous earth, it frequently becomes a matter of importance to farmers to be able to aſcertain the quantities, ſome being found ſo poor in this material as to have only a twentieth or thirtieth of their weight, in order to decide on their advantage in preference to lime, chalk, or other ſubſtances to be brought from a diſtance. A ſimple and eaſy method, founded on the knowledge that this earth commonly contains about forty per centum of its weight of fixed air or carbonic acid, is propoſed by the ſame profeſſor. It is merely by ſaturating the marle with the muriatic or ſome other

the latter, by the circumſtance of the harder ſorts of marle remaining a great length of time upon, or within the ground, before they are fully decompoſed or broken down.

This kind of manure produces beneficial effects on moſt ſorts of ſoil in its different forms; the ſhell, ſtone, and thoſe kinds of marle which abound moſt with calcareous earth, or which have ſand in their compoſition, are the moſt adapted to the ſtrong, ſtiff, clayey ſoils, as by the inſinuation of ſuch matters they are not only rendered more light and friable, but a great part of the injurious moiſture which they contain is removed. But thoſe in which clay is conſiderably predominant are found more advantageous in the light, dry, ſandy, gravelly, and loamy ſoils, as by ſuch ſubſtances the defects of lightneſs are remedied, and the neceſſary moiſture in ſome meaſure preſerved. On the ſtronger ſorts of loamy ſoil, clayey marle will moſtly be improper, as it has much tendency to render ſuch ſorts of land more wet and adheſive, by which they may be greatly injured. Theſe have been found to be the effects reſulting from the application of it even upon a temperate loam, in ſome parts of Suſſex. And beſides it is ſometimes apt to bring up coltsfoot, a weed which is difficult to be eradicated *.

In the quantity or proportion of theſe ſubſtances that is applied, there is conſiderable difference in different diſtricts, a circumſtance which, in ſome degree, depends upon the nature of the ſoils; the heavy clayey or loamy requiring, in general, a much larger proportion than the light ſandy or gravelly. The general quantity employed may probably be eſtimated at from about two to four or five cubic roods of ſixty-four yards to the ſtatute acre, according to the ſtate of the marle, and particular nature and condition of the grounds on which it is laid. It may, however, in many caſes, be the moſt adviſable practice not to apply too thick a covering at one time, but to have recourſe to light dreſſings more frequently, as by ſuch a method the fertility of the land may be better preſerved and kept up, and the crops be rendered more abundant †.

acid, and marking correctly the loſs of weight which it ſuſtains by the extrication of the fixed air. Thus, if two hundred grains of marle be introduced into a veſſel with a little water, and muriatic acid poured upon them until the bubbles ceaſe to riſe, the loſs of weight being then found to amount to forty grains, the marle contains one hundred grains of calcareous earth. The proportion of calcareous earth contained in different marles may alſo be determined by diſſolving it by means of the muriatic acid, diluting the liquor with water, paſſing it through a filtering paper, and then precipitating the calcareous earth from the clear liquid by a ſolution of ſome fixed alkaline ſalt.

* See Middleton's Survey of the Agriculture of Middleſex, p. 312.

† See Holt's Survey of the Agriculture of the County of Lancaſter.

This manure is employed both on lands in a courſe of tillage, and graſs lands, from different ſeed crops. On the former it is generally made uſe of as a preparation for barley, turnips, and other ſimilar crops, or applied upon clover or other new leys, previous to their being ploughed up for wheat; in which modes of making uſe of it, the common practice is to leave it ſpread out upon the ſurface for ſome length of time before it is turned in, in order that it may be well reduced into a powdery form; for the more perfectly the marle is broken down and ſpread out, the more effectual it is found in promoting the growth of the crops. In its application in the latter caſe, it is frequently laid on in too large quantities, or left too long in its lumpy ſtate; from both which circumſtances diſadvantages are produced to the growth of the graſs, when either to be cut for hay or fed off by cattle: as by the former, where the marle contains much of the argillaceous material, a kind of cruſt is formed that prevents its ſpringing, as happens where the ſtiff mud of ponds, and ſuch-like manures, are too thickly laid on lands; and from the latter, the graſs is not only injured by the ſmall clods, as is experienced where imperfectly reduced clayey earth is applied, but the effects of the manure are prevented from being fully exerted, on account of its not being well broken, and carried down to the abſorbent roots of the graſſes, by the frequent rains that may take place after its application.

Some farther attention ſeems likewiſe requiſite in the uſe of this manure, as well as to the mode of cropping with it. When employed in large proportions, whether upon the heavier or lighter ſorts of land, a conſiderable ſpace of time appears, from experience, to be required to elapſe, before it can with advantage be had recourſe to again; for if this circumſtance be not properly attended to, or too many white crops be ſucceſſively taken, a very great degree of exhauſtion is ſoon produced, as has been experienced in many of the marling counties of England, and in Forfarſhire in Scotland. Theſe injurious conſequences are, however, found to be eaſily prevented, by adopting the alternating ſyſtem of corn and graſs, or other green crops. And it is probable that by taking corn and graſs crops in ſucceſſion, or, after having one or two grain crops, letting the land be laid down for two or three years with artificial graſſes, the application of marle in ſmall quantities might be more frequently renewed, to the great advantage of the farmer, and the improvement of the land. In ſome of the places where this kind of manure is made uſe of, as in Lancaſhire, ſomething of this practice is adopted with much benefit. And

when mixed with dung and other ſubſtances, in the form of compoſt, it is generally found capable of being repeated, at ſhort intervals, with the moſt beneficial effects. From theſe facts it would therefore ſeem probable that ſuch injuries are rather to be aſcribed to the mode of cropping, than to the nature of the manure. Something may alſo, perhaps, depend on the manner in which it is applied, as it has been found to be more efficacious when well mixed and incorporated with the ſoil, than where this has not been the caſe; and as it has been found highly advantageous in promoting and bettering the condition of the graſs lands in ſome diſtricts, while in others it has been objected to as injuring them, it is ſtill farther probable that much depends on the ſtate and manner of its being put in or upon lands, and that it is only where it is laid on in a moderate ſuitable proportion, and after it has been well broken down and reduced into a fine powdery form, ſo as that it may be very minutely and intimately blended with the ſoil, that its beſt effects can be exerted.

The circumſtance of this ſubſtance having been uſed with great ſucceſs in ſmall proportions, as eight or ten buſhels to the ſtatute acre, after being burned in proper kilns, ovens, or other places, and well reduced into a fine powdery ſtate, ſo as to be ſown with the hand over the crops, as a top dreſſing, appears alſo to favour the ſame concluſion *.

And the general practice of digging it up in the ſummer months, and ſpreading it over the ground in a lumpy ſtate, in order that it may be acted upon and reduced by the heat of the ſun and the froſts during the ſucceeding winter, is likewiſe in proof of the ſame thing.

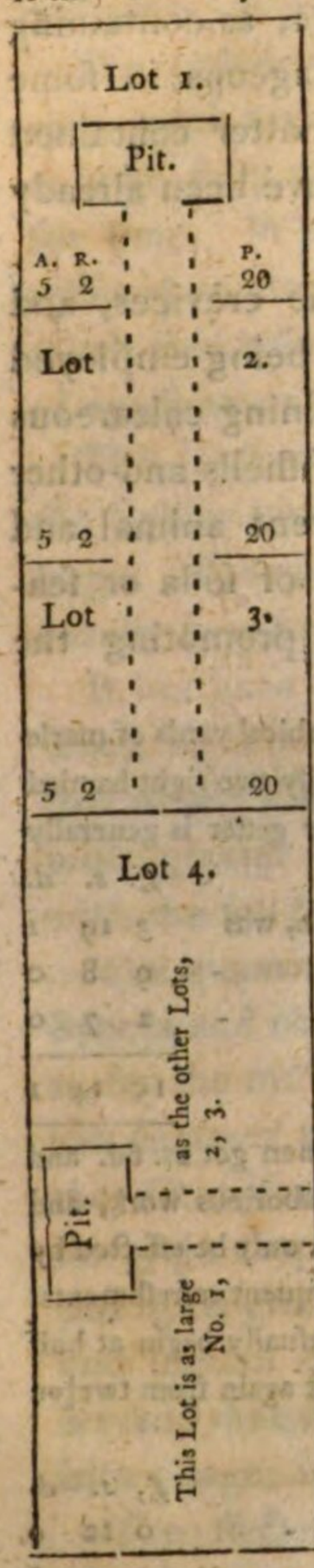
This kind of manure is frequently procured by looſening and undermining large maſſes, and letting them fall down by forcing piles in above them; but great care ſhould be taken in performing the buſineſs, as there is often much danger by the lumps giving way ſuddenly. In fixing upon places for opening pits, attention ſhould be had to the injuring of as little land as poſſible, to having them as convenient as poſſible for carriage, to their having the leaſt difficulty of draught, and to the water that may ſtagnate in them early in the ſpring producing the leaſt poſſible miſchief afterwards. Such pits ſhould, indeed, only be made as can be eaſily laid dry †.

The expence attending the uſe of this ſubſtance as a manure, muſt vary conſiderably, according to the proportions in which it is applied, the facility with which it is dug from the pit, and the diſtance which it is carried. In

* See Holt's Report of the Agriculture of Lancaſhire. † Ibid.

this way it may vary from two to ſix or ſeven, and in ſome caſes twelve or fifteen pounds the ſtatute acre*.

* The differences in the expence from the circumſtances of conveying it from different diſtances, is thus ſhewn by Mr. Holt, in his Survey of the County of Lancaſter.



Suppoſe the Lot 1 be thirty rods ſquare, and the pit right in the centre, ſo that its greateſt diſtance from the pit be fifteen rods every way. The cartage will be 18s. per rod; and, to ſave fractions, call the field ſix acres; then the account will ſtand as under:

Cartage, per rod -	18s.	
No. of acres - -	6	
	108	
No. of rods laid per every acre	6	
	648	

£.32. 8s. Total amount of expence of Lot 1.

Now, if Lot 2 be marled out of the pit in Lot 1, the additional expence will be 12s. per rod, or 54l. being forty-five rods from the pit.

And, if Lot 3 be to be marled ſtill from the ſame pit, the additional expence will be 26s. per rod, or 44s. the whole; the diſtance from the pit being ſeventy-five rods, and the expence 79l. 4s.

Again, Lot 4 being as large as the other three, and the pit in the centre, the extreme diſtance will be forty-five rods each way, and the cartage will be 21s. per rod, of ſixty-four cubical feet, and which will amount to 113l. 8s.

The comparative eſtimate ſtands thus: Lot 1, 32l. 8s.—Lot 2, 54l.—Lot 3, 79l. 4s. Total amount of which is 165l. 12s.—Three times 32l. 8s. is 97l. 4s.—Balance ſaved by having a pit in each field would, he ſays, be therefore 68l. 8s.—The expence of Lot 4 is 113l. 8s.; and from which ſubtract 97l. 4s. and the balance is 16l. 4s. The above will, he thinks, evidently prove the advantage of proximity to the marle: but a pit in the middle of a field is not only an eye-ſore, but a nuiſance; therefore, if poſſible, ſhould be avoided. Nor is the advantage ſo great in the middle as may be thought; ſince, in coming out of the pit, there being only one pace, ſome part of the ground muſt of neceſſity be gone twice over; whereas, if on one ſide of the field, and central, all the land lies immediately before the pace of the pit.

He ſtates the expence of marling upon Bootle Marſh, about the year 1780, to be as follows:

	£.	s.	d.
Getting and filling, per rod of 64 cubic yards - - -	0	10	0
Spreading - - - - - -	0	2	2
Carting; the average diſtance from the middle of the pit to the middle of the land, 60 rods - - -	1	9	0
	2	1	2

In this calculation, he obſerves, there are ſix carts, five in motion, each goes the diſtance of twelve rods, whilſt one ſtands in the pit to be filled. The ſize of each cart is 20,736 inches (cubical),

In ſituations where both this manure and lime can be procured, the choice ſhould be regulated by the facility and cheapneſs of obtaining one in preference to the other, the ſtates of purity in which they preſent themſelves, and the nature of the ſoils to which they are to be applied. Marle, where it contains much clay, may be preferable for a light ſort of ſoil; while lime, as containing a larger portion of calcareous matter, may be more advantageous in ſome clayey ſtiff ſoils. The quantity or proportion of calcareous matter contained in different marles, may be aſcertained by the methods that have been already given for lime-ſtone.

The ſhelly ſand brought up and depoſited in beds, in the crevices, and level parts of the ſea coaſts, is another ſubſtance capable of being employed with great benefit as a manure, not only on account of its containing calcareous matter in a fine attenuated ſtate, from the rubbing down of ſhells and other ſubſtances of the ſame kind, but from the mixture of different animal and vegetable recrements with it, and a ſmall portion of muriat of ſoda or ſea-ſalt being retained. The laſt, from its known property of promoting the

uſually drawn by three horſes; the weight of the load about 15 cwt. and two cubical yards of marle make about three loads. The number of workmen are ſix fillers and getters; uſually two right-handed men at one wheel, and two left-handed at the other, with one filler behind: one getter is generally ſufficient.

	£.	s.	d.
Getting, filling, and ſpreading, to the acre of 64 yards to the rod, on Bootle Marſh, was	3	19	1
Cartage	9	8	0
Digging for the marle, clearing the head, expences at finiſhing, &c. per acre	2	7	0
	15	14	1

There were, he ſays, about 6½ rods laid upon the acre on this occaſion. The men got 2s. 6d. and the carts 7s. 6d. per day. Getting and filling marle, it is remarked, is very laborious work, and requires the utmoſt exertion to obtain theſe wages; and that this work, after all, can only be effected by young men in their prime, cheered by the company of fellow-labourers, and frequent refreſhments. Five working days, he ſays, are reckoned equal to ſix at other work, for they uſually begin at half paſt four in the morning, and reſt one hour at breakfaſt, from eight to nine; reſt again from twelve till two, and then work till ſix; and generally get out nine rods per week.

The preſent price (1795) is—

	£.	s.	d.
For getting and filling, per rod	0	12	0
Spreading	0	2	6
Carting	1	13	0
	2	7	6

In the Middleſex Report it is ſtated to be this—"Four men digging and filling eighty cart-loads, at 4s. a ſcore, ſpreading included, is 16s. One man and four horſes, two days, at 12s.—1l. 4s. Total expence per acre, 2l."

putrefaction and decay of animal and vegetable matters when in ſuch quantities, as well as that of deſtroying different kinds of living inſects, may contribute greatly to the good effects produced by it. This, indeed, appears ſtill more probable, from that which is taken from underneath the water, or from ſuch banks and places as are daily covered by the tides, being the moſt efficacious.

The proportion of calcareous matter contained in ſuch ſubſtances muſt vary very much according to the particular circumſtances of the caſes, which can only be fully aſcertained by ſuch proceſſes as thoſe which have been propoſed for lime. Where the quantity of calcareous matter is large, and in a very reduced or attenuated ſtate, it is by much the moſt valuable; as when there is much ſand amongſt it a much larger quantity will be required, and the expence of application be of courſe much increaſed.

This ſubſtance ſeems more proper for the clayey or loamy ſoils than thoſe of the lighter kinds, eſpecially where the proportion of calcareous ingredient is large. When equally ſpread, and well incorporated with ſuch lands, it is generally found to produce goods effects for a great length of time.

It has been obſerved that a conſiderably leſs quantity of calcareous matter, when in this fine ſtate, will have a more ſenſible effect, than when it is in that of any kind of earthy marle, as it admits of being ſpread over the ground with greater equality, and of being more minutely and intimately blended with the ſoil *.

The quantity employed muſt obviouſly be different according to the circumſtances and nature of the ſoil, as well as the ſand; but twenty tons to the acre is, for the moſt part, conſidered as a proper dreſſing. It is frequently applied on the ſummer fallows for wheat, and ſometimes as a preparation for barley; it may likewiſe be laid on the clover, or other leys, before they are turned down for grain crops, but in theſe caſes ſo large a quantity is not neceſſary. When put upon graſs land, in not too large a proportion, it commonly produces great and ſudden effects, the crops quickly becoming very luxuriant. It is alſo obſerved, that ſuch lands as have been treated in this way, when again brought into tillage, moſtly produce abundant grain crops.

The effects of this ſort of manure on the weſt coaſts of the northern parts of the iſland, have been very extraordinary, eſpecially upon the heathy or moſſy ſoils; and it is ſuppoſed that ſuch kinds of ſand are more common on the eaſt coaſts than has been generally ſuppoſed †.

* See Anderſon's Eſſays, vol. I. p. 562. † Ibid, p. 563.

A ſhelly kind of ſand, which in digging up appears with blue veins, has lately been uſed in ſome parts of Lancaſhire as a ſubſtitute for marle with conſiderable ſucceſs *.

It ſeems not improbable but that oyſter as well as other kinds of ſhells, if they were ſufficiently reduced by ſuitable machinery, might be of great uſe as a calcareous manure for the heavier ſorts of land. When met with in large maſſes, or extenſive beds, it might probably, in ſome caſes, be economical to calcine them, and apply them as lime, either in the ſimple ſtate or that of combination with earthy materials.

Common ſand can ſcarcely be conſidered as a manure, but it is frequently found ſerviceable in the ſtiff, clayey, and loamy ſoils, in leſſening their tenacity, and rendering them more friable and mellow. It has been laid upon rough paſture and meadow land, in large quantities, with excellent effects, rendering the ſurface more equal, and bringing up a cloſe thick crop of graſs with much white clover. The quantity muſt be proportioned to the ſtiffneſs of the ſoils; it is, however, probably better not to apply too much at one dreſſing.

MANURES FROM THE *AGENCY* AND *DECOMPOSITION* OF *SALINE SUBSTANCES.*

SUBSTANCES that contain much ſaline matter in combination with their earthy and other ingredients, are found, in many inſtances, when properly employed as manures, to contribute greatly to the ſupport of vegetation. The materials principally made uſe of in this way are the refuſe of different manufactures, ſuch as bleaching and ſoap-boiling, where they can be procured in ſufficient quantities, as in the vicinity of large towns, and where ſuch manufactories are carried on in an extenſive manner; the aſhes remaining after the combuſtion or burning of various green vegetable matters, wood, pit-coal, peat, &c.; and ſome other ſubſtances, ſuch as ſoot and ſea-ſalt.

It is moſt probably to the different alkaline principles contained in theſe ſubſtances, from the great facility and power which they poſſeſs of acting upon and diſſolving the parts of animal and vegetable matters, eſpecially ſuch of the latter kind as have been rendered inſoluble by the abſorption of the oxygen, or pure air of the atmoſphere, from long or frequent expoſure to it, and even foſſil coal under ſimilar circumſtances, and by this means forming new ſaline

* Halt's Survey, p. 126.

compounds which are ſoluble, that their beneficial effects as manures are chiefly to be aſcribed*. The ſame author alſo remarks, that as ſuch inert or inſoluble vegetable or peaty matters, when decompoſed or reduced into a ſtate of ſolubility by alkaline ſubſtances, aſſume a browniſh-red colour, and become inſipid; the alkalies, in ſuch caſes, muſt enter into combination, and be neutraliſed by the acid or acids contained in them, which will be found to be the phoſphoric and the oxalic, or acid of ſorrel; from which will be formed, according to the nature of the alkali contained in the ſubſtance made uſe of, phoſphats and oxalts of pot-aſh, ſoda, or ammoniac, which are matters capable of promoting the growth of plants.

But theſe ſubſtances, beſides their forming in the ſoils, or the earthy materials with which they are mixed, ſuch compounds as are beneficial in promoting the growth of vegetables, may be uſeful in many caſes when properly applied, and uſed in ſufficient quantity, in correcting acidity, in altering the ſtate or condition of the lands, as by the taking away of moiſture from the ſurface where it prevails in an over-proportion in meadows and paſtures, and thereby ſupports crops of coarſe vegetables, and by rendering the texture of ſuch grounds as are under the plough more open and friable, conſequently more ſuitable for the reception of the roots of corn corps.

The refuſe of bleachers contains vegetable and mineral alkali, in ſuch proportions as render it incapable of being employed without being previouſly mixed with other materials; for which purpoſe, freſh mould or peat earth ſhould be procured; and after having been well mixed and blended with it, in the quantity of about eight or ten parts of the earth to one of the refuſe, a proportion of rotten dung ſuitable to the purpoſe for which the manure is intended, may be added, by which means a good manure will be formed.

The waſte of ſoapers is another ſubſtance that may be made uſe of in the ſame way; but in this there is a conſiderable portion of lime, mixed with the alkaline matter. The lees, or liquors, which are drawn off after the making of ſoap, as containing much alkaline ſaline matters, may likewiſe, where they can be procured in ſufficient quantities, and at a reaſonable rate, be made uſe of in the ſame manner.

All theſe ſubſtances, when combined with rich vegetable mould, or peaty matters, and made uſe of as manure, are found to be the moſt advantageous and uſeful upon the ſtiff clayey and loamy ſoils; as in ſuch ſorts of land they probably not only contribute to the increaſe of the crops by furniſhing ſuch ſoluble

* Dundonald on the Connection of Agriculture with Chemiſtry.

matters as can be readily taken up by their abſorbent roots, but, by leſſening their ſtiffneſs and tenacity, render them more proper for their reception.

The quantity of theſe manures which is neceſſary, muſt, as in moſt other caſes, be various, according to the particular circumſtances of the land upon which they are applied, and the views of the farmer.

They are laid upon lands in the ſtate of tillage, as well as thoſe under graſs; in the firſt caſe they are moſtly either put on in the ſtate of compoſt, at the rate of about ten loads to the acre, juſt before the ſeed furrow is given, or ſown upon the ſurface, and harrowed in with the grain; but in whichever way they may be applied, it will be requiſite to have them ſpread as equally as poſſible, in order that they may produce their effects in the moſt extenſive and perfect manner; and in the latter, though they may in ſome inſtances be uſed alone, it is probably a much better practice to have them mixed with ſuch earthy ſubſtances as have been deſcribed, before they are applied to the ſwards, as by ſuch a practice their effects as a manure may be rendered more complete and laſting. To graſs lands they are frequently uſed to the amount of from one hundred to one hundred and fifty buſhels. And moſt graſs lands are improved by the application of ſuch manures, but eſpecially ſuch as are wet and diſpoſed to the production of coarſe ſour vegetables, ſuch as ruſhes, wild ſorrel, &c.

The aſhes, or earthy ſaline matters, which remain after the combuſtion of different freſh vegetable products, are all of them beneficial when judiciouſly employed as manures; but as this means of producing manure is much too waſteful and uneconomical a practice to be adopted, except in particular inſtances, as where wood and other vegetable productions are very abundant, and uſed commonly as fuel, or where they cannot be readily cleared away by other more advantageous methods, as ten or fifteen parts, and in ſome caſes conſiderably more, of ſuch materials are diſſipated and loſt during the proceſs, they can but ſeldom be made uſe of in the way of dreſſings for land. Where they can be procured in ſufficient quantities for theſe purpoſes, they may, probably, be employed to the greateſt advantage by being mixed with a good portion of rich vegetable mould, or peat earth, and a quantity of well-fermented dung; as, in ſuch a compound ſtate, they are capable of being applied more extenſively, and at the ſame time in the moſt favourable condition for the ſupport of vegetation. When made uſe of on the heavy ſoils, the quantity of aſhes in the compoſt ſhould be much greater than on thoſe of the lighter kinds; they are, in general, the moſt effectual when applied as a top dreſſing to graſs lands, eſpecially ſuch as are commonly termed ſour, or have much tendency to the production of moſs.

Peat-earth is a ſubſtance met with in many diſtricts, and which after being cut and exſiccated by the heat of the ſummer, is made uſe of as fuel in ſuch places. By the conſumption of peat in this way, a very conſiderable loſs, ſo far as manure is concerned, is however ſuſtained; as, in many caſes, nineteen parts out of twenty of the material is diſſipated and carried away in the proceſs of combuſtion, which, as it has been ſhewn, that the inert vegetable or peaty matter, produced by the action of oxygen, or the pure air of the atmoſphere, for a great length of time, is capable of being rendered ſoluble, by mixing lime in certain conditions with it, and ſtill more effectually by alkaline ſaline ſubſtances, might have been preſerved and rendered uſeful as manure *. In ſome places however, as in Berkſhire, it is the common practice to dig up peat-earth, merely for the purpoſe of burning it into aſhes, in order that it may be uſed as a manure.

As freſh or green vegetable productions are only capable of yielding alkaline ſaline ſubſtances when burned, none being afforded by the combuſtion of dead or decayed vegetable matters, it ſeems probable that the aſhes of peat-earth ſeldom contain much ſaline matters. It is however obſerved by ſome writers, that all peat-earths afford alkaline ſaline matters in a greater or leſs proportion when burned, and that in ſome it is from a twenty-ſecond to a thirty-ſecond part of their weight †. The aſhes produced from the burning of peat about Reading in Berkſhire, which long experience has ſhewn to poſſeſs great fertilizing powers, are aſſerted to contain no alkaline ſalts, nor, from the haſty analyſis of them which was made by the writer, any ſaline matter, except a ſmall proportion of ſulphat of magneſia or Epſom ſalt ‡. But it is added, that if the analyſis had been more carefully made, and when the aſhes were newly burnt, they would moſt probably have been found to contain a hepar of lime, which is a ſaline ſubſtance ſoluble in water, while gypſum, the ſubſtance to which it returns on being expoſed to the air, is inſoluble. The fertilizing effects of theſe aſhes may, therefore, probably materially depend upon this hepar of lime. This is rendered ſtill more probable from the obſervation, that " the hills on each ſide of the meadows which produce the Newbury *peat-aſhes*, conſiſt of chalk, eaſily diſſolvable by heavy rain, which waſhes it off the ridges down the furrows, ditches, and ſtreamlets, to the low grounds, where mixing with the floods, it is floated over

* Dundonald on the Connection of Agriculture with Chemiſtry, p. 108.

† Millar's Dictionary, art. Manure.

‡ Dundonald on the Connection of Agriculture with Chemiſtry, p. 106.

the meadows, and depoſited in the peat. Conſequently that the peat of this diſtrict differs from that of moſt others, by the quantity of chalk which it contains; and, when dug, dried and burnt, the fire reduces the chalk to lime, and the reſt to aſhes. Hence Newbury aſhes are a mixture of lime and vegetable aſhes; and that it is very probable that any common peat-aſhes, or the aſhes of rough graſs land, of turf, heath, furze, ling, wood, &c. produced by the operation of paring and burning, being mixed with chalk lime in due proportion, would be as equally fertilizing as theſe noted aſhes *."

There is another circumſtance that may cauſe a difference in the ſaline and other ſubſtances contained in the aſhes of different peaty earths, which is the preſence of mineral ſprings. When, by this means, an over-large portion of ſulphat of iron, or green vitriol, happens to be preſent in the peat, the aſhes produced from its combuſtion muſt, in conſequence, become injurious, or at leaſt much leſs beneficial to the growth of vegetables, than in caſes where it does not exiſt.

The prejudicial effects of this ſubſtance may, according to the obſervations of Lord Dundonald, be corrected by the uſe of either lime, magneſia, alkaline ſalts, or dung; but that preference is to be given to magneſia and alkaline ſaline ſubſtances, as they not only decompoſe the vitriolic ſalt, but form Epſom and Glauber ſalts, or vitriolated tartar, ſubſtances which have been found to promote the growth of vegetables.

When dung is made uſe of, the vitriolated iron is brought into its metallic condition, and the ſulphuric acid, thus ſet at liberty, combines with the ammonia or volatile alkali produced from the dung, and forms ſulphat of ammonia; or it may, by uniting with the calcareous matter, and by the additional aſſiſtance of the inflammable or putreſcent matter of the dung, be converted into a hepar that may be ſerviceable in vegetation.

Peat-aſhes may be uſed as a manure, either by being harrowed in with the grain, or ſown as a top dreſſing after the crops have come up; in the former caſe they ſhould be employed in a ſomewhat larger proportion than the latter. In the latter method of uſing them the beſt practice is to ſow them over the crops before they are grown too high; and if the weather be rather inclined to wetneſs, it will be the more favourable: the quantities commonly employed in theſe caſes are from fifteen to twenty buſhels the acre, according to the ſtate or

* Middleton's View of the Agriculture of Middleſex, p. 298.

condition of the land. When laid on graſs lands, whether thoſe of the artificial or natural paſture kinds, theſe aſhes frequently effect great improvements, rendering the graſſes both thicker and finer.

Peat, in the reduced ſtate of duſt, is ſometimes alſo made uſe of with conſiderable benefit; but it would ſeem that this ſort of earth may generally be employed to moſt advantage by being well mixed and incorporated with ſuch ſubſtances as contain alkaline ſalts, or with alkaline hepars, or by a mixture of ſulphat of ſoda, or Glauber ſalts, with lime in its active ſtate *. The powdery or duſty matter of pit-coal might, likewiſe, probably be uſed with the ſame advantage if prepared in a ſimilar manner, as it is capable of being rendered ſoluble by ſuch means.

It is aſſerted by the ſame ingenious author, as the reſult of experimental trials, that the effects of peat-earth, mixed and incorporated with alkaline ſaline ſubſtances, are equal, if not ſuperior, to thoſe from dung, the weight of each being the ſame†. If this fact be well founded, the advantage of employing peat-earth in this way, inſtead of converting it into aſhes, is ſtill greater than has been ſuppoſed above.

The aſhes of pit-coal, where they can be procured in ſufficient quantities, as in large towns where it is principally employed as fuel, are, when applied as manures, found to be uſeful in many reſpects; but as theſe can contain ſaline matter only in proportion to the quantity of freſh vegetable products that may have been conſumed along with them, little of the effect which is produced by them can depend upon it; much more, probably, ariſes from the portion of calcareous earth which they contain. Something too, in many caſes, probably depends on the animal ſubſtances that may have been occaſionally burnt, or afterwards mixed with them, before they are made uſe of as a manure. They may alſo be ſerviceable on the ſtiffer ſorts of ſoil, by rendering them more open and diſpoſed to admit the roots of growing vegetables. That they may be beneficial in theſe ways ſeems to be ſhewn by their utility in the ſtiff clayey grounds from which brick-earth has been dug, and on what are generally termed ſour lands. On the more tenacious loamy ſoils they may operate by giving friability, and at the ſame time the calcareous principle, in a ſmall degree, when it is deficient. This is a concluſion which is further ſupported by their having been found from experience to be much leſs uſeful in the poorer ſorts of land.

By the application of theſe aſhes, in the vicinity of London, to the ſtiff ſoil

* Dundonald on the Connection of Agriculture with Chemiſtry, p. 108.

† Ibid, p. 183.

from which the brick-earth has been taken, they render it ſufficiently friable to afford a good crop of beans, a vegetable which, though it grows well on the heavy ſoils, could not otherwiſe be produced on lands ſo very ſtiff as the bottoms of brick grounds generally are found to be. After this crop has been taken, it is generally found that ſuch grounds are in a condition to admit of graſs ſeeds being ſown with the ſucceeding crops. But, except in ſuch caſes as the above, this manure is probably the beſt adapted to graſs lands as a top dreſſing; it may, however, occaſionally be uſed in this way to the young grain crops. The proportion which is neceſſary muſt be different according to the intention of the farmer, the nature of the crop, and the ſtate of the land.

Soot is another ſubſtance that experience has ſhewn to be of conſiderable utility, where it can be collected in ſufficient quantities and applied to land as a manure. The beneficial conſequences reſulting from the uſe of this ſubſtance depend, probably, in a great degree, on the quantity of alkaline ſaline matter which it contains; which, by its action on the rich vegetable mould of the ſoil or earth with which it is mixed, may render it more capable of ſupplying the nutrition of plants; and it may bring the thick oleaginous matter of the ſoot into ſuch a ſtate as to be capable of ſolution or diffuſion in water, and thereby in a condition to be taken up by the abſorbent roots of vegetables. The earthy matter of this ſubſtance, as well as that of different kinds of aſhes, may probably be rendered more ſuitable for the purpoſe of promoting vegetation, by their having been expoſed to the action of fire, as is well known to be the caſe with clay. The great ſtate of tenuity or fineneſs in which ſoot is found may, likewiſe, be ſerviceable, as by that means it becomes capable of being more regularly and more extenſively mixed with the ſoils on which it is applied. Indeed the good effects of moſt ſubſtances employed as top dreſſings depend, in ſome meaſure, upon this circumſtance.

Soot, as it contains alkaline ſalt in a conſiderable proportion, might probably be uſed with greater advantage by being well mixed or blended with rich mould, or peat-earth, and by ſuch a method the quantity of manure would be greatly increaſed. This ſhould not, however, be attempted where the deſtruction of inſects forms any part of the deſign of the farmer.

This manure is chiefly made uſe of as a top dreſſing to grain crops and graſs lands. On the former it has been found extremely uſeful in deſtroying the wire-worm and other deſtructive inſects. This is probably effected by the bitter oleaginous liquid formed from the union of the alkali and the oil of the ſoot, impregnating theſe parts of the plants on which they feed, and

thereby cauſing them to be rejected by ſuch inſects. It may alſo produce ſome advantage in this reſpect by promoting a rapid vegetation, and thereby rendering the texture of the plants, very quickly, too firm to be preyed upon by them*. That ſoot is very powerful in promoting the vigorous growth of vegetable crops, is evinced by the change which takes place after ſowing it over ſuch young wheat crops as have a yellowiſh ſickly appearance, as they frequently put on, in a very ſhort time afterwards, the healthy green aſpect. On meadow and paſture lands experience has likewiſe ſhewn it to be highly uſeful, not only by encouraging the growth of a finer ſort of graſs, but by deſtroying or correcting the frequent diſpoſition of ſuch grounds to produce moſs, and ſome other coarſe ſorts of vegetable productions. The proportion of this, like that of all other manures, muſt vary according to the circumſtances of the caſe. The common quantity is generally from about forty to fifty buſhels on the acre.

Where aſhes, ſoot, or any other material that contains ſaline matters, are to be employed as manures, they ſhould always be preſerved in ſheds, or other convenient places, from rains, or the accidental application of water to them, as where this practice is neglected the ſaline ſubſtances are ſoon diſſolved and carried away in a liquid form. It is chiefly from this cauſe that ſubſtances of this kind which have been long expoſed without being covered, are often found ſo inferior in their effects to thoſe which are freſh or newly made. On this account alſo, if ſuch ſubſtances are laid on land at too early a period of the ſeaſon, they will be liable to have much of their valuable properties carried away by the rains that may take place.

Muriat of ſoda, or ſea-ſalt, is a ſubſtance, the utility of which, for the purpoſes of manure, ſeems not yet well aſcertained, as by ſome writers it is conſidered as poſſeſſing conſiderable powers of promoting vegetation, while others have experienced little or no advantage from its application; but as the experiments of Pringle and Macbride ſhew, that though it may prevent putrefaction when employed in large proportions by its antiſeptic property, yet that when uſed in ſmall quantities, it has evidently a tendency to promote the proceſs. On this account it may therefore be ſerviceable when incorporated with farm-yard dung, and other animal or vegetable matters, in ſmall portions.

It is alſo thought probable by an ingenious writer, that from calcined clay, as it is met with in the more looſe and ſoft kinds of bricks, having a power of decompoſing ſea-ſalt—as is ſuſpected from the circumſtance of his having re-

* Dundonald's Connection of Agriculture with Chemiſtry, p. 138.

marked in a cellar where ſalted meat had been kept for a great length of time in a ſalting-tub, which was attached to one ſide of the wall, that on the other there was a great efflorescence, which he conceived to be natron or foſſil alkali—it may, when more tardily combined with oxygen, by expoſure to the air, from the different proceſſes of cultivation, poſſeſs the ſame property; and that the great diverſity and contradiction that has been obſerved in the effects of ſea-ſalt may have depended on this circumſtance, as it might thus be highly uſeful on clayey ſoils, though it was of little or no advantage to others *.

It is alſo further ſuppoſed, by the ſame author, that as common ſalt is a ſtimulus which affords little or no ſupport in the way of nouriſhment, but which may excite the abſorbent veſſels of vegetables to exert themſelves more powerfully, it may, in a certain proportion, augment their growth by inducing them to take up a greater quantity of nutrient matter in a limited time, and to perform their circulation and ſecretions more vigorouſly. But that in a large quantity its ſtimulant powers may be ſo great, as to deſtroy them by exhauſting the irritability of their veſſels, as has been found by Mr. Van Uſlar, in watering plants with oxygenated muriatic acid.

Theſe circumſtances probably further explain the reaſon why ſea-ſalt, when made uſe of in large proportions, is frequently injurious to land, and the growth of crops; while employed in ſmall quantities it produces highly beneficial effects.

This ſubſtance may likewiſe be uſeful in other ways, as, from its known power of deſtroying various kinds of inſects, ſuch as worms, ſlugs, grubs, ſnails, &c. a power which an able writer ſuppoſes to depend on the exciting of greater evacuations from their bodies than they are capable of withſtanding, much nutrient matter may, in different caſes, be provided for the ſupport of vegetation †.

As every-where in the vicinity of the ſea a ready means of obtaining this ſaline material in unlimited quantities offers itſelf, it may deſerve more particularly the notice of the agriculturiſt; and more eſpecially as many other ſubſtances that are known to contain or be impregnated with it, ſuch as the weed thrown up by the tides, and the ſand over which they flow, can be eaſily procured.

The bittern, waſte, or refuſe, of ſalt-works, which generally contains muriat of magneſia in large proportions, is found to poſſeſs very great ſceptic qualities, and

* Darwin's Phytologia, p. 226.

† Dundonald on the Connection of Agriculture with Chemiſtry, p. 138.

may therefore be highly uſeful when mixed with dung, or earthy matters. The experiments that have been made with this ſubſtance likewiſe ſhew it to be capable of promoting vegetation in a conſiderable degree.

But in whatever way ſubſtances of the ſaline kind may produce their effects in promoting vegetation, when employed as manures, it is evident, from their containing in themſelves little or nothing of ſuch matters as are capable of affording nouriſhment to plants, that they may, in moſt caſes, be made uſe of to the greateſt advantage by being mixed and incorporated with ſuch ſubſtances as they are capable of acting upon and reducing to a ſtate proper for the ſupport of vegetable crops; ſuch as rich earthy materials, imperfectly reduced dung, and other matters of a ſimilar kind. Where ſubſtances that contain the muriat of ſoda, or ſea-ſalt, are employed, if the opinions which have been ſtated above be correct, they might probably be applied to much advantage by being mixed with imperfectly burnt clay, when reduced to the ſtate of powder. And if, upon trial, they ſhould be found effectual in this form, they might be very conveniently made uſe of in the way of top dreſſings to graſs or grain crops in the ſpring.

MANURES FROM THE *COMBINATION* OF *DIFFERENT SUBSTANCES.*

It is evident, from what has been already obſerved on the nature of the different ſubſtances that are capable of being made uſe of as manures, that they may frequently be mixed and blended with each other, or with ſubſtances of other kinds, and by ſuch means be not only conſiderably increaſed in quantity, but in many caſes rendered more effectual and more ſuitable for application than in their ſimple ſtates; but at the ſame time, that ſome of them may be mixed and incorporated in this way with much more advantage than others: for, though the general experience of farmers has fully ſhewn the great importance and utility of employing compound manures, or compoſts, little attention has, till lately, been paid to the compounding or mixing together of ſuch ſubſtances as are, from the principles which they originally contain, or which are formed from them in the changes which they undergo in the different ſtages of their decompoſition, adapted to act in the moſt ſuitable manner for producing ſuch combinations or alterations in the materials, as are capable of being beneficial in the promotion of vegetation when they are employed as manures.

Farm-yard manure, which is the moſt general application of any, from its

being formed by the decay of various kinds of vegetable matters, ſuch as hay, ſtraw, fern, and many other materials of a ſimilar nature, with which the dung and urine of animals is incorporated and combined, muſt be conſidered as a compound ſubſtance. And from the large proportion in which ſuch vegetable productions enter into its compoſition, and the quantity of earthy materials that is in moſt caſes, eſpecially where the management is upon a judicious plan, added by the laying of ſuitable bottoms, it is not ſo frequently neceſſary to be blended with other ſubſtances that are uſually employed in forming compoſts. But from moſt of the vegetable materials that conſtitute the chief part of this ſort of manure, being made uſe of in a dry and hard ſtate, they do not ſo quickly ferment or run into the ſtate of decay, notwithſtanding the proportion of animalized matters that may be mixed with them; it therefore becomes an uſeful practice to turn them over, by which their complete putrefaction may not only be promoted, but the different materials be more minutely blended together, on both which accounts they may become more uſeful when applied as manure upon land. In the forming of this manure, care ſhould alſo be conſtantly taken that the heaps be ſo ſituated as that they may not become too dry, or too much ſoaked in water, as in either caſe they muſt be greatly injured. Whenever it may be requiſite to incorporate any earthy material with this ſort of manure, the agricultor ſhould always carefully attend to the ſtate or richneſs in which it may exiſt in the yard, and proportion ſuch additions accordingly. It will, however, never demand nearly ſo large a proportion, as ſuch manures as conſiſt almoſt wholly of animal matters.

Where animal matters are collected and thrown together in any quantity, there can be little doubt but that a great increaſe of good manure may be provided by mixing with them, as has been already obſerved, rich ſurface-mould, peat-earth, or the ſcrapings of old ditches and roads; as by ſuch a practice the ammonia formed during the decompoſition of the animal ſubſtances is prevented from eſcaping, as would otherwiſe be the caſe, which, by combining with and acting upon the earthy materials, quickly renders them proper for the purpoſes of manure. As ſubſtances of the animal kind have been ſhewn to run very rapidly into the ſtate of putrefaction, they may frequently be incorporated with ſuch vegetable materials as are little diſpoſed, or with difficulty made, to rot or become putrid, and by ſuch means uſeful compoſts be more expeditiouſly formed. In making uſe of ſuch earthy ſubſtances as have been mentioned, it may be of much advantage to have them expoſed to the influence of the atmoſphere for a conſiderable length of time, frequently turning them over, before they are mixed with the

manures, as by ſuch means they become in a more pulverized ſtate, and are capable of being more intimately blended with ſuch materials, and afterwards ſpread over the land with much greater equality, a circumſtance upon which their effects very much depend. If, in performing this buſineſs, the earthy ſubſtances be formed into a ſort of ridge, about five or ſix feet in height, and nearly the ſame breadth in the bottom, they will be in the moſt proper ſituation for being united with dung, or other matters that may be employed.

From the experiments of a late practical writer it would ſeem, that ſuch earthy materials as have been mentioned may be made uſe of to a very conſiderable extent, eſpecially where the manure to be mixed with them is of the animal kind *.

Lime is a ſubſtance that has often been too indiſcriminately made uſe of in the formation of compoſts, but which, by attending to the following circumſtances, may admit of being employed extenſively and with more beneficial effects. Where the deſtruction or decay of green or freſh vegetable matters, eſpecially thoſe of the more coarſe and hard kinds, is intended, it ſhould be uſed in its cauſtic ſtate in ſmall quantities; as in this condition, thus ſparingly employed, it reduces more expeditiouſly the ligneous and more hard parts of ſuch matters to an earthy ſtate; and as, during its action in this way on theſe ſubſtances, ſuch elaſtic matters are ſet at liberty, as by their ſubſequent combination afford ammonia or volatile alkali, it may frequently be a beneficial practice to blend ſuch earthy ſubſtances as have been juſt mentioned with them, and thereby prevent the elaſtic matters from being diſſipated and loſt. If a portion of rich farm-yard dung be afterwards incorporated with theſe materials, a valuable compoſt will be formed.

Quick-lime is likewiſe found uſeful ſometimes in bringing the hard parts of dead vegetable matters, as tanners' bark, fern, ſtraw, cabbage-ſtalks, leaves, &c. quickly into the ſtate of earth or mould; but whenever it is made uſe of in this way, it ſhould be had recourſe to only in a very ſcanty proportion to thoſe of the matters with which it is mixed, as when it is employed in large proportions it is liable, from the heat that is extricated or diſengaged by its combining with the moiſture of ſuch ſubſtance, being ſo augmented during its ſlaking, as to convert them into a coaly ſubſtance that is inſoluble, and at the ſame time to force off, in the form of gas, their elaſtic principles, except ſuch a quantity of carbonic acid as may combine with the lime during the proceſs.

* Experienced Farmer, vol. II. p. 55.

By the common practice of blending quick or cauſtic lime with farm-yard dung, much loſs is frequently ſuſtained; as by its violent operation upon ſuch ſubſtances, ſome of the elaſtic matters are not only ſet at liberty and quickly conveyed into the atmoſphere, but, with what remains, inſoluble ſaline compounds are formed which cannot aſſiſt vegetation *.

The complete putrefaction of ſuch manures, when neceſſary, is probably the beſt promoted by the uſe of lime in its mild ſtate, and the various means which have been already deſcribed.

When lime is to be blended with peat or earth, the moſt advantageous method is to uſe ſuch lime as has been newly made and well ſlaked, in the proportion of about one part of the lime to five or ſix parts of the peat or mould, which ſhould not be too much exſiccated, or dried, before it be made uſe of. By this means the heat which is generated will not be ſufficient to produce any injurious conſequences, either by forming a coaly matter, or forcing off the elaſtic principles in the ſtate of gas. And the volatile alkali which is compoſed in ſuch caſes, by being allowed to enter into combination, as it is formed, with that part of the peat or mould which has not been acted upon by the lime, in conſequence of its being employed in ſo ſmall a proportion, and in its effete ſtate, will form a ſoluble ſaline ſubſtance, capable of promoting vegetation †.

There are other ſubſtances that may be ſtill more beneficially employed in forming compoſts with peat earths, when they can be procured in ſuch quantities and at ſuch cheap rates as render them capable of being made uſe of in this way. Theſe are alkaline ſaline matters, or ſuch ſubſtances as contain them in any quantity; as by mixing theſe with the peaty materials in the way mentioned above, they are made perfectly ſoluble, while by the uſe of lime only ſuch a proportion of them is rendered ſoluble as can be acted upon by the quantity of ammonia or volatile alkali formed during the time it is mixed with them. And, farther, inſoluble compounds, ſuch as have been juſt noticed, are formed in the latter caſe.

It is common, in many diſtricts, to make compoſts with lime and mould on the head-lands, or other parts of the fields on which they are to be applied. This cannot however be done to any great advantage, except where the ſurface mould is rich in vegetable matter; but wherever ſuch compoſts are to be formed, the grounds

* Dundonald on the Connection of Agriculture with Chemiſtry, p. 120.

† Ibid, p. 111.

ſhould be ploughed or dug up to a conſiderable depth, and reduced into as perfect a ſtate of pulverization as poſſible; freſh lime may then be placed, in ſmall heaps, all along the middle of the ridge or head-land, and the earth in this fine ſtate be thrown over them, in the proportion of four parts of earth to one of lime, and kept cloſe by being beaten down with the ſpade: from the gradual ſlaking of the lime, in this ſituation, by the moiſture of the earth, elaſtic matters are ſet at liberty, which combining with the mould or earth, render it ſtill further reduced, and by being afterwards very intimately blended by means of the ſpade with the very fine particles of the lime cauſed by the ſlaking, a valuable compoſt is made for the ſtiffer ſorts of ſoil, eſpecially if a ſmall quantity of good rotten dung be incorporated with them.

The animalized and other matters contained in farm-yard dung, or compoſt, from their being, in that ſtate, for the moſt part mixed and blended with large quantities of earthy materials, produced by the decaying or rotting of vegetable and other ſubſtances, and the depoſiting of ſoil or mould underneath them, as has been obſerved above, are ſeldom capable of admitting any further additions with advantage. But wherever there is much liquid matters oozing from ſuch compoſts, or ſtagnating about the bottoms of them, ſome of the earthy matters which have been mentioned ſhould be laid round them in order to abſorb or take them up, and prevent the great waſte that muſt otherwiſe take place, as may be often obſerved where dung compoſts are made in fields, the ſides of roads, or on other waſte grounds. This ſhould be more particularly attended to where ſuch compoſts are laid in ſituations that have not been properly formed as dung-ſteads; and, in ſuch caſes, it may frequently be an uſeful practice to place a conſiderable thickneſs of ſuch materials in the bottoms, before the farm-yard compoſt is carted out, and laid upon them, as by that means the manure heap may be greatly increaſed, at the ſame time that a proper ſubſtance for the volatile alkali contained in ſuch liquors to act upon, is ſupplied. The utility and advantages of this method of proceeding are fully confirmed by its becoming the prevailing practice wherever there is any attention paid to economy in the forming of compoſt manures.

There are many circumſtances, ſuch as the nature and ſtate or condition of the land, the goodneſs of the manures, the diſtance they are to be carried, and the expence of procuring them, which render a difference in the quantity of ſuch compound manures neceſſary, and which can only be properly judged of by the perſons who have the application of them: on the heavier kinds of land, ſuch as thoſe of a clayey or deep loamy nature, ſuch compoſts as are conſtituted of the lighter ſorts of earthy materials, ſhould always be employed; while on the

thinner and more light ſorts of ſoil, thoſe which are formed of clayey, loamy, or the more tenacious earthy matters, will be found the moſt ſuitable. In general, the allowance of ſuch manures ſhould be from ſixteen to twenty loads to the ſtatute acre, each containing ſeventeen or eighteen hundred weight. On many occaſions, however, a much larger proportion may be required, and in others a leſs may anſwer the intentions of the farmer.

The mixture of dung, litter, and other materials, which is gradually collected and formed into heaps in the farm-yard, is, in general, when employed without having any other ſubſtances incorporated with it, laid on ſuch lands as are under preparation for wheat, turnip, or barley crops. It is likewiſe in ſome ſome places laid on for a pea crop, where wheat is intended to be the ſucceeding crop*.

The compoſts, or manures, collected from the ſtreets of large towns, are commonly formed of a great variety of ſubſtances, as the recrements of decayed vegetables, putrid animal matters, and aſhes; but from their abounding, for the moſt part, with ſubſtances of the latter kinds, they may, on the principles we have ſo often ſtated, be in many inſtances greatly increaſed by having rich ſurface mould, or peat earth, blended with them; and by ſuch a practice, where the manure heaps are in a condition to admit of it, the riſk of waſte, by the eſcape or diſſipation of their more fluid contents in the aërial or gaſſeous ſtate, may be effectually guarded againſt.

Such additions can, however, be only advantageouſly made, where the proportion of animalized materials in the manure is conſiderable; in other caſes it will be better to employ them in the ſtate in which they are formed and collected.

This ſort of manure is capable of being made uſe of with great benefit on moſt ſoils, and in preparation for different ſorts of grain crops, as well as thoſe of graſs. When applied in the proportion of fifteen or twenty tons to the acre, it generally produces great fertility; it ſhould, however, like all other manures, be laid on according to the particular circumſtances of the ſoils, and the nature of the crops for which it is employed.

The trials of practical agricultors fully ſhew, that the moſt advantageous compoſts are thoſe which are formed by the combination of earthy materials with animal matters. In this way ground bones and whale-blubber have been found highly uſeful; but the effects of the former are aſſerted to be the moſt powerful when applied on the moiſter ſorts of ſoil †.

* Modern Agriculture, vol. II. p. 249. † Experienced Farmer, vol. II. p. 47.

From the whole of what has been advanced above, it is therefore probable, that by proper attention to the mixing together of ſuch ſubſtances as are adapted to act upon each other, and ſuited to the ſtate of the ſoil, manures may be increaſed and rendered much more ſerviceable in promoting the growth of crops, and augmenting the fertility of land, than they have hitherto generally been.

MEANS OF *AUGMENTING* AND *PRESERVING MANURES.*

ON due attention being paid to the increaſe of manures and the modes of preſerving and managing them, in a great meaſure depends the general fertility of farms, and the luxuriance or goodneſs of the crops that are grown upon them. It is therefore a matter of great intereſt and importance for the farmer to ſee that nothing is waſted or thrown away that can poſſibly be converted to ſuch a purpoſe. That there are many ſubſtances that may be rendered uſeful in this way, which have hitherto been little regarded by the cultivators of land, there can be little doubt, when the daily waſte of animal, vegetable, and other matters, that takes place in every country, from their being carried away by rivers, or conſumed by fires, is fully conſidered.

Another great cauſe of loſs in the production of manures is from the want of adopting or putting in practice ſuch modes of management, in reſpect to different ſubſtances, as are capable of rendering them fit for the purpoſe of application, in the moſt quick and expeditious manner; for it is obvious, that if by properly attending to ſuch means the ſame quantity of manure can be prepared in a ſhort ſpace of time, which under other circumſtances muſt have required a long one, much increaſe of manure may be effected, and conſequently great advantages be gained by the cultivators of the ground. What is neceſſary to be done in order to facilitate and haſten the decompoſition and reduction of different materials into the proper ſtates for being applied to the ſoil, we have already ſeen to be, in ſome meaſure, the free admiſſion of atmoſpheric air, a quantity of moiſture ſuited to the condition of the matters made uſe of, and a due degree of heat. And alſo by the proper blending of animal with vegetable ſubſtances, in the incipient ſtages, and the addition of lime, according to circumſtances, and in proportions ſuited to the ſtate and nature of the ingredients.

As the principal reſource, on moſt farms, for the production of manure, is the farm yard, it ſhould be conſtructed in ſuch a manner as that every thing may with eaſe and facility be converted to the purpoſe. In general one dung-

ſtead may be ſufficient; but where the ſize of the farm is large, two or more may be neceſſary, as the putrefaction of ſuch heaps proceeds with greater regularity and expedition, from the acceſs of air and moiſture being more free, when they are not made too large; and, beſides, they can be more conveniently turned over or removed. The parts of the yard on which they are ſituated ſhould, while they are convenient for depoſiting the dung, and other matters from the ſheds and other offices, upon, be neither too much elevated, ſo as to cauſe the dung to become dry, or ſo greatly depreſſed as to favour the ſtagnation of water upon it, and thereby deprive it of the properties moſt eſſential to the promotion of vegetation. Before each of the dung-ſteads a reſervoir, or baſin, ought to be made, into which not only the drainings from all the different ſheds and places where animals are fed or kept, may empty themſelves, but likewiſe the urine from the neceſſaries, the ſuds from the waſhhouſes, and the waſhings of the various utenſils employed in the family. Without theſe advantages in the conſtruction of farm-yards, much loſs of manure muſt daily occur from the liquid matters of ſuch places continually running away, and being otherways waſted, as well as from their not being made uſe of to forward the converſion of other ſubſtances into the condition of manures.

Where theſe and ſuch other ſuitable accommodations as have been already deſcribed are provided, the farmer will have little more to do than be careful in ſaving or providing ſuch matters as are ſuitable for the purpoſe, and cauſe them to be properly placed and removed, in order to have them ſpeedily reduced into the ſtate of manure, and the quantity of his dung heaps thereby greatly increaſed *.

In this view various vegetable matters, ſuch as hay, ſtraw, fern, leaves, ruſhes, coarſe graſſes, flags, and many other aquatic plants, ſhould be preſerved and collected in as large quantities as poſſible; by allowing nothing of the kind to be ſold or carried from farms, except in ſome particular inſtances, as where they are ſituated near large cities, or towns, where ſuch articles can be advantageouſly diſpoſed of for the purpoſe of feeding and littering horſes, or other animals, and at the ſame time an equivalent in good manure be brought back to the farm; by mowing and raking together the wheat or other ſtubbles, the fern from the commons, and leaves where they can be obtained, as in the vicinity of parks and other woodlands, and by cutting the coarſe graſſes and aquatic vegetables at ſuch periods as they are in the moſt juicy and ſucculent ſtates. The

* See the Section on Farm Buildings and Offices.

whole, after being ſufficiently dried, ſhould be carried to the farm yards, and ſtacked up in convenient ſituations, either in or near them, for the purpoſe of being made uſe of as litter.

Beſides theſe means, there are others that equally demand attention; every leiſure opportunity ſhould be taken, before the commencement of the foddering ſeaſon, to bring into the farm-yards ſuch quantities of peat or boggy earth, rich ſurface mould, marle, dry mud from ponds or ditches, ſcrapings of roads, loam, and other ſubſtances of the ſame kind, as can be conveniently obtained.

Such materials as are neceſſary being by theſe methods procured, the beſt mode of proceeding ſeems to be that of covering the whole of the yards, where the cattle ſtand and tread, and even the pig-ſties, in ſome caſes, with layers of theſe earthy matters, eight, ten, or more, inches thick, according to the number of cattle, and other circumſtances; and alſo to depoſit in the reſervoirs before the dung-ſteads, proper quantities of the ſame ſubſtances, for the liquid matters which come into them to act upon. Upon theſe earthy bottoms, at the time the cattle are confined, pretty thick litterings of one or more of the materials that have been collected and ſtacked up, may be placed, and the ſtables, cow and ox ſtalls, pig-ſties, &c. cleaned out upon them. Where it is the practice to tie up and confine the cattle in the night-time, the ſtraw, or other ſubſtances, after having been broken down and reduced by littering them, may be uſed for covering the bottoms of the yards, by which means their decay may probably be rendered more quick and convenient. It appears alſo probable, that where ſtubble, fern, ruſhes, leaves, or other vegetable matters, the textures of which are hard and ligneous, are employed, their decay, or reduction into the ſtate of manure, may be greatly expedited by means of a ſlight portion of lime, in its active ſtate, being ſpread over the earthy bottoms before they are applied, as has been found to be the caſe with tanners' bark.

Where the matters made uſe of in the way of manures are liable to be rendered too dry by the weather, their putrefaction and decay may be much promoted, as we have already ſeen, by having them ſprinkled over occaſionally with water, which may be conveniently and readily performed by having a pump, with troughs, fixed properly for the purpoſe; or, where theſe are wanting, from a pond in the yard.

To render the plan the moſt effectual it is capable of, the whole of the cattle ſhould be ſtrictly confined to the fold or foddering yards, during the winter, and not turned out, as is frequently the caſe, into the paſtures, by which the making of much manure is prevented, great injury, in many ſituations, done to the

grass lands, and the stock, from being much exposed to cold and other causes, benefited in a far less degree than is commonly imagined. By pursuing this method, from the great consumption of straw and the coarser sorts of food, by the young lean cattle, and of hay and luxuriant vegetable roots or plants by the others, such quantities of animalized matters are voided, as by mixing with the bottoms of the yards hastens their putrefaction, and affords not only an immense increase of manure, but of such as is of a very valuable kind. If there be not a sufficient proportion of animal dung and urine incorporated with the other matters, which can seldom be the case where the cattle are not regularly confined to the fold-yards, the manure, though it may be nearly as large in quantity, is found by experience to be very inferior in its effects when applied to land.

Where the number of cattle confined in the fold-yards is great, it may be necessary, occasionally, to remove the bottoms, and the matters littered upon them, to the dung-steads, after they have become in some degree manures, by being well saturated and blended with the urine and other animalized matters. These must be immediately replaced by others in the way we have just noticed.

The earthy substances from the reservoirs must also be occasionally emptied out upon the dung heaps, and replaced by quantities of fresh materials of the same kinds, and the stems of different gross vegetable products from gardens or other places when it can be done.

At the close of the season, when the cattle are turned out of the yards, the heaps of manure which have been thus collected and thrown together, are to be turned over, in order that the animalized matters may thereby not only be still more intimately incorporated with the earthy substances, but, likewise, that more of the pure air of the atmosphere may be retained among the clods, from their being rendered much smaller by such means, and the putrefactive process be thereby more perfectly produced. After this business has been well performed, as little delay as possible should be suffered to take place before the manure is applied to the soil; as from the combination of oxygen or pure air with the carbonaceous material of the dung, and of azote with hydrogen, under these circumstances, such fluid matters are formed as constitute its most beneficial properties, but which are afterwards continually wasting so long as it remains unapplied to the ground.

On these accounts, as well as those which have been already mentioned, manure heaps should not be made too large, but of such sizes only as that they can be expeditiously turned over and put upon the land. And another advantage

which attends the having different heaps and their not being large, is, that one can be prepared and carted away at a time, without the other's being in the leaſt injured by any delay that may happen from unforeſeen cauſes.

By the mixing of lime with manures compoſed of earth, and dug, in the more advanced ſtages of their preparation, ſome increaſe of quantity may likewiſe be produced; and at the ſame time, as we have already ſeen, by its uniting with the nitrous acid during its formation, may prevent its being thrown off into the atmoſphere in a gaſſeous form, or readily waſhed down from the compoſts by rains; and thereby preſerve a ſubſtance that has long been found uſeful in promoting vegetation.

As a great waſte of manure is continually taking place from the evaporation of the more liquid parts of ſuch heaps, where they are much expoſed to the action of the ſun or winds, and the waſhings of the rains, it would no doubt tend greatly to the ſaving of ſuch matters, and at the ſame time conſiderably promote their complete putrefaction and decay, to have them placed in ſituations that are much ſhaded by trees or other means. In the farm yards, it is probable that moveable coverings of ſome light kind of material might be highly advantageous for the ſame purpoſes. By theſe means the manure heaps, in ſuch places, may be effectually ſcreened from the action of the ſun in the ſummer, and prevented from being injured by the heavy rains or ſnows that fall in the winter ſeaſon. The manures which have been preſerved from the effects of the weather in this way have alſo been found, by practical agricultors, to be far more efficacious in promoting the growth of crops, than under other circumſtances, conſequently capable of going much further*.

Different modes have been purſued, in different places, in order to procure manure from the articles of food and other matters produced on the farm; by ſome it has been ſtrenuouſly contended, that the moſt advantageous plan is to have the whole of the hay and ſtraw conſumed by the different animals, without employing any of them in the way of litter, floors or ſtandings for them being conſtructed in ſuch a manner, as that they can be tied up and kept clean and dry merely by ſweeping, without being littered with ſtraw or other ſimilar materials; while others aſſure us, on the ground of actual experience, that the method of eating the hay by the ſtock, and employing the whole of the ſtraw, as well as other matters, in the way of litter, as we have ſeen above, is by much

* Annals of Agriculture, vol. XXXIII. p. 593.

the moſt effectual in promoting the increaſe of manure. But though each of theſe methods may be practiſed, with more or leſs advantage, according to the nature of the farms;—as where there is much graſs and little tillage land, the former may be preferable; but where the quantity of graſs is ſmall, and that of arable ground large, the latter;—it is probable, that a judicious combination of both may be the moſt beneficial, eſpecially where, in addition to the common articles, coarſe vegetable and rich earthy matters are provided and made uſe of in the way which has been mentioned, as by ſuch a combination the full effect can only be produced. In the former method, the loſs by means of digeſtion and animalization is probably much greater than has been generally ſuppoſed by thoſe who have maintained the ſuperior utility of the practice.

The ſoiling of horſes, and different kinds of cattle, with rich green food, as clover, ſummer-tares, and other artificial graſſes, cut freſh every day during the ſummer ſeaſon, and placed in cribs in the ſheds or foddering yards, the bottoms or floorings of which have been prepared and ſtrewed with earthy materials and litter, in the manner we have already ſeen, is a practice by which great additions may be made to the dung-hills, as the evacuations of cattle fed in this way are very conſiderable. It is remarked by the earl of Dundonald, that experience only can teach, or warrrant the belief of how few acres of ground, under the culture of artificial graſſes, when cut green, and daily given to working horſes and other cattle, will ſuffice for their maintenance. The artificial graſſes, or plants, beſt adapted to this purpoſe, are, he ſays, red clover, tares, and ſaint-foin. None of thoſe ſucculent plants with large ſtems and leaves anſwer, he obſerves, ſo well to be depaſtured as to be mown; not only on account of the injury they receive in being bruiſed by the treading of cattle, but by being conſtantly cropped and kept ſhort, they are deprived of the nouriſhment which they principally receive by their ſtems and leaves. Saint-foin is, he thinks, beſt ſuited to chalky or dry ſoils, and to the ſouthern parts of Britain. It has often been tried without ſucceſs in the northern parts of England, and in Scotland. Winter tares have alſo been ſown, but have not been found to anſwer any valuable purpoſe. Clover and ſummer tares, therefore, ſhould, he thinks, be the only plants of which the cultivation on a large ſcale ſhould in theſe parts be attempted; and every prudent farmer will take care to have a full ſupply of them, as in the event of a ſuperabundant quantity for green food, theſe crops are equally proper for hay. Tares ſhould always, he ſays, accompany the culture of clover, to ſupply the deficiency of herbage between the firſt and ſecond cuttings of the clover.

The quantity of manure that may be formed in this way is, probably, much greater than can be ſuppoſed by thoſe who have not actually made a trial of the method: by ſome French writers it is ſtated, that from three or four hundred ſheep, kept in this mode, manure ſufficient for nearly an acre of land may be daily procured *; and the manures thus obtained are likewiſe aſſerted to be preferable to dung procured in the common method †.

Beſides, the great waſte that unavoidably muſt take place in feeding off ſuch crops is prevented, and the whole of them immediately brought into uſe; and the manure thus produced becomes of a ſuperior quality, from the vaſt quantities of worms and other inſects that are generated during the hot ſummer months.

By means of covered ſheep-folds, a great increaſe might alſo be made annually to the ſtock of manure. If this neglected, but highly beneficial, practice was regularly employed here, as is the caſe in many other countries, by having proper ſheds and incloſures for the purpoſe conſtructed, of any ſlight materials, near to the fold-yards, or other more convenient places of the farm, ſo that the ſheep might have freſh air and ſufficient liberty to run about, and at the ſame time have the means of being ſheltered from rain, ſnow, and the coldneſs of the winter ſeaſon, the advantages to the flock would likewiſe be conſiderable, beſides the great ſupply of manure that muſt be provided. In order to promote the latter advantage, the bottoms or floorings of ſuch ſheds and incloſures ſhould be covered with ſuch earthy materials as have been recommended for the cattle yards, and alſo littered upon in the ſame manner; all of which ought to be removed and cleared away to a heap, or the common dung-ſteads of the farm-yards, as often as they become perfectly ſaturated and blended with the dung and urine of the ſheep, and freſh materials of the ſame kinds ſupplied. In bad weather it will be advantageous to keep them conſtantly in theſe covered folds, and feed them with hay in ſtanding racks; but when it is fine they may be ſuffered to go into the paſtures in the day-time, and only be put into the folds during the night.

The practice of keeping ſheep in covered folds is made uſe of in Flanders for the purpoſe of raiſing manures with great ſucceſs; and very dry ſand is ſometimes employed for the bottoms of the folds inſtead of litter.

Where the houſe-lamb ſyſtem is carried on to any extent, the preparing and

* Laillevault. Recherches ſur la Honille d'Engrais, tom. II. p. 69.

† Teſſier Obſ. ſur pluſieures Maladies des Beſtiaux, p. 90.

littering of the ſheds and yards, into which the ewes are occaſionally put and the lambs kept and ſuckled, might be practiſed with great advantage in reſpect to the production of manure, as animals under ſuch kinds of management are conſtantly found to void urine and dung in much larger quantities than in the ordinary courſes of feeding.

The ploughing down of rich green crops in their moſt ſucculent ſtates, in the way that has been already deſcribed, is alſo a means of increaſing manure that may occaſionally be adopted with advantage.

By feeding off different green crops on the land by ſheep, bullocks, or other animals, much fertility may occaſionally likewiſe be given to the ſoil, at a cheap rate, as the expence of carriage is prevented, and a conſiderable ſaving of manure thereby effected. Mr. Middleton ſeems of opinion, that by this mode of management the great loſs of urine and dung that unavoidably occurs in the other methods may be the moſt effectually prevented; "For," ſays he, "in the ſtables, cow-houſes, ſheds, fold-yards, and dung-hills, even under the beſt management, there is a great waſte, perhaps of half, including dung and urine; under ordinary management three parts of this manure is loſt; but in the ſoiling of tares, turnips, cole, clover, &c. in the fields, there is *no* loſs; the whole is immediately applied, without the coſt of carriage, to the enriching of the ſoil." It is evident, however, that in this way there muſt be much more waſte than is here ſuppoſed: by evaporation, from the action of the ſun and wind over ſo extenſive a ſurface, much of the valuable matters of manure, in ſuch ſituations, muſt be daily carried away; and the more fibrous or ligneous parts of the materials, which are rejected as food by the cattle, from their being thinly ſcattered over a large ſpace, becoming dry and hard, muſt be longer before they decay, or are rendered fit for the purpoſes of manure, than where they are collected together in larger quantities and in more confined ſituations.

Another means of increaſing manures to a very great extent, is by adopting ſuch methods as may effectually prevent the ſoil and urine of privies, and the various animal and vegetable materials that are continually thrown into them, in cities and large towns, from being uſeleſsly retained in deep pits, or places conſtructed for the purpoſe, or inconſiderately waſhed away and waſted, by being conveyed into rivers or ponds by ſewers and drains.

It is ſtated, that, from want of ſuitable modes of preſerving ſuch ſubſtances, the annual loſs, in this country, is probably not leſs than five millions of cart loads, which, if turned to the uſes of agriculture, would be worth to the cultivators

of the ſoil two millions and an half, and to the community five millions of pounds ſterling * !

Beſides this, the eagerneſs which is manifeſted in many other countries to preſerve and promote the increaſe of ſuch manure, as in the Netherlands, Sweden, China, and Japan, according to the accounts of different travellers, ſhews that it is a ſubſtance of great utility, and that a vaſt ſource of fertility is neglected.

The moſt eaſy and convenient methods of preſerving ſubſtances of this kind in the country would be, probably, by having pits formed for the reception of them, as near as poſſible to the dung-ſteads in farm-yards or other places, and prepared with floors of clay, or ſome other material through which the liquid matters could not readily paſs; theſe might be connected with the privies by proper drains, and have covers fitted to them, in order that a quantity of mould, peat earth, ſaw-duſt, lime, ſtems of coarſe garden plants, or other ſubſtances of the ſame ſort, might be occaſionally placed in them, and removed to be blended with the common dung heaps, as often as they became fully reduced by putrefaction, and well ſaturated and impregnated. But in large towns or cities, where ſuch manures are produced in great quantities, reſervoirs or baſons of large ſizes ſhould be conſtructed, with floors of the above kind, and be connected with the privies of different parts, by means of ſewers or drains. Such reſervoirs ought to be ſo ſituated as to be capable of being emptied with eaſe and facility, as often as neceſſary, by perſons appointed for the purpoſe, and their contents carried away in the night-time. Where there is the convenience of rivers, however, as in London, and many other populous cities and towns, a large proportion of ſuch manures might, in moſt caſes, be readily emptied from baſons of this ſort, formed on their banks for the purpoſe, or perhaps from the extremities of the common ſewers themſelves, by means of proper ſluices, into covered boats or barges, and thus cheaply carried to a diſtance, for the advantage of agriculture; a method, in ſome reſpects, practiſed with ſucceſs in Sweden †.

As this kind of manure is extremely liable, from the agitation of the carriage in which it is moved, to become ſo liquid as to be conveyed with great difficulty, it is probable, that by having ſuch earthy or other ſubſtances as have been mentioned above, or as could be conveniently procured in ſuch large

* Middleton in Tranſactions of the Society of Arts, &c. vol. XVII.

† Communications to the Board of Agriculture, vol. I. p. 347.

cities or towns, ſuch as the long littery dung from livery ſtables, lime rubbiſh from the pulling down of old houſes, and the freſh earth dug up in preparing the foundations for new ones, mixed and blended with it in the pits or reſervoirs, for ſome time before they are cleaned out, the difficulties attending the carriage of it might not only, in a great meaſure, be obviated, but the diſagreeable ſmell iſſuing from it be much corrected, and the quantity of manure greatly augmented.

By ſome method of this nature, under the management and direction of proper perſons, vaſt ſtores of fertility might be provided in ſuch places for the neighbouring diſtricts, which inattention or popular prejudice at preſent withhold from the uſes of agriculture.

In the vicinity of the ſea, where ſhell and other ſmall fiſhes can frequently be procured in large quantities, by having them well mixed and incorporated with good ſurface-mould, peat-earth, or other ſimilar matters, a vaſt increaſe of good manure may alſo be produced. In ſuch ſituations too, the weeds cut from the ſides of the rocks, or which are thrown up by the tides, when collected into heaps, and mixed with ſmall proportions of lime and ſuitable quantities of mould or earth, may contribute greatly to the increaſe of the compoſt heaps on the farms.

It is obſerved by an intelligent writer, in ſpeaking of calcareous ſubſtances, that the recent ſhells obtained from fiſhing towns, operate much more powerfully as an animal manure than as a calcareous matter, when firſt applied; and that it is not impoſſible but that man may, in time, fall upon ſome contrivance for obtaining this animal calcareous manure in much greater abundance and perfection than it has hitherto been obtained. "There is," ſays he, "a ſmall ſpecies of freſh-water *wilk*, which increaſes ſo faſt, as in a ſurpriſingly ſhort time to fill a conſiderable ſpace with ſolid wilks, if a few of them have been placed in a proper receptacle for that purpoſe, and water duly adminiſtered to them. If then ponds were prepared for this purpoſe, and properly ſtocked with this animal, and if they were allowed to increaſe till a bed of them, of conſiderable thickneſs, was accumulated, might they not then," ſays he, "be taken out in abundance to be employed as a manure? Theſe, if bruiſed under a ſtone like a tanner's wheel, to reduce the ſhell to ſmall fragments, would certainly," he ſays, "form as rich and efficacious a manure as could poſſibly be deviſed; nor could there be any difficulty in diſpoſing the ponds in ſuch a manner as to afford a conſtant annual ſupply *."

* Anderſon's Eſſays, vol. I. p. 569.

The vegetable mould or other materials contained in the bottoms of ditches, and in boggy, hollow places, where water frequently ſtagnates, and large crops of aquatic or other plants alternately vegetate and decay, may likewiſe be dug up and applied with benefit to ſoils for which they are proper, either in the ſtate in which they are found, or after they have been formed into compoſts with dung, lime, or ſome other ſubſtance of a ſimilar kind.

Clay may alſo be employed with great advantage on ſandy ſoils, and ſave other more valuable manures; it ſeems, however, to be the moſt ſerviceable for this purpoſe after it has been imperfectly burnt in clamps or kilns, probably from the proportion of oxygen or pure air that is thus combined with it, or with the metallic matters which it contains. In ſhort, it is neceſſary, in order to increaſe the ſtock of manures on farms to the greateſt poſſible extent, to be careful that none of ſuch animal or vegetable ſubſtances as are capable of being converted into manure, be thrown away or conſumed by fire, but that they be all conveyed to the dung-ſteads in the farm-yards or other places, or laid in heaps of themſelves, and ſuffered to paſs into fermentation, by which they may be ſpeedily reduced to manure. Where the matter thus made uſe of chiefly conſiſts of weeds and the ſtems or roots of coarſe plants, ſuch as peas, beans, cabbages, docks, nettles, &c. their decay may be greatly promoted by a little quick-lime being blended with them. Such heaps ſhould alſo be covered over pretty well with ſome of thoſe earthy matters that have been ſo frequently mentioned.

As we have ſeen that the different materials which are made uſe of for the purpoſe of manure, paſs through different ſtages of decompoſition and decay, in each of which ſuch matters of the ſolid or fluid kinds are formed, as are capable of contributing to the nutrition and ſupport of vegetable crops, but which are liable to be diſſipated or carried away by the agency of various cauſes, it may be neceſſary to guard againſt ſuch waſte by keeping the dung-heaps covered, in every ſituation, as much as poſſible, with earth or ſoil, both in the early periods in which heat is evolved, and at the later ones, when ammonia or volatile alkali is formed; as by ſuch management the proceſſes of decompoſition, when too rapid, may be reſtrained, and the elaſtic matters that are gradually ſet at liberty be abſorbed by theſe coverings, while the more fluid ones are detained by the earthy bottoms on which they had been placed, and thus the whole of the valuable properties of the manure be preſerved.

GENERAL APPLICATION OF *MANURES.*

IN the application of manure to land, ſeveral circumſtances are neceſſary to be conſidered, ſuch as the ſtate or condition of the ſubſtances which are to be made uſe of, the nature of the ſoils on which they are to be laid, the kind of crop that is to be promoted by them, and the ſeaſon in which they are put into or upon the ground.

As we have already ſeen that changes are continually taking place from the moment the materials of the dung-heap are thrown together, to the period in which they are reduced into a black carbonic earthy matter; and that in moſt of the different ſtages through which they paſs in this proceſs of decompoſition, ſuch ſubſtances are formed as are capable of contributing to the nutrition and ſupport of vegetable crops; it ſeems probable, that in caſes where manures are to be turned into the ground, and ſuch crops cultivated as require a ſupply of nouriſhment for a conſiderable length of time, they ſhould be employed in their long or more imperfectly reduced ſtates, as by the heat which is evolved in the commencement of their diſſolution, the proceſs of early vegetation may be greatly promoted, and their gradual decompoſition and decay afterwards, under the ground, afford a more durable and regular ſupply of nutrient materials, and thereby contribute more effectually to the growth of the crops; but that where they are to be buried in, or applied to, the ſurface of the ſoil, and intended merely for the benefit and ſupport of ſuch crops as are of ſhort duration, or quickly arrive at their full growth, they may be more advantageouſly made uſe of after they have been more fully and completely reduced, as in this ſtate the manure is, in the caſe of graſs lands, not only capable of being ſpread out in a more regular and uniform manner, by which it becomes more evenly as well as more generally carried down to the roots of the plants by rains, but it is in the moſt ſuitable condition for allowing the young plants the means of ſpringing up with facility, and at the ſame time, whether uſed under or upon the ſoil, of affording the crops that abundant ſupply of nouriſhment which is neceſſary to their ſpeedy growth and great luxuriance, and by theſe means to contribute the moſt perfectly to the promotion of their increaſe.

Beſides the above advantages of long, or imperfectly, decayed manures, they have others that depend on the ſoil into which they are turned, and the nature of the crops that are ſown or planted with them. Where they are employed

in ſuch ſtiff, clayey, or loamy grounds, as have a great tendency to become dry and hard, and thereby incapable of admitting the tender fibrous roots of grains or other plants to ſpread or extend themſelves, and draw in more abundant ſupplies of nouriſhment, they may be uſeful by keeping the earth around them in a more open and porous ſtate, from the ſlowneſs of their decompoſition, and the gradual and continued manner in which the different elaſtic matters are ſet looſe and united with the ſoil. Hence, when barley, or ſuch kinds of grain as require a rather light and open ſtate of ſoil, and thoſe bulbous or knobby rooted plants, ſuch as potatoes, that require much room to ſhoot and extend themſelves, are cultivated on ſuch ſtiff ſoils, they are generally found to be the moſt productive where ſuch long or imperfectly reduced manures have been made uſe of in the preparation of the land.

And as in the ſlow and gradual decompoſition of the materials which are made uſe of for manures, when ſlightly depoſited beneath the ſoil, there is much leſs waſte of heat and thoſe elaſtic matters which contribute ſo greatly to the ſupport of vegetation, than where they are made to undergo the various proceſſes of diſſolution in large maſſes, as in dung heaps, they may probably ſometimes on that account be moſt advantageouſly employed in this ſtate.

On this principle too the ploughing down of freſh vegetable crops, in many caſes, in their moſt ſucculent ſtates, may be a more economical as well as more beneficial practice; eſpecially in ſuch light and dry kinds of ſoil as will more readily admit of their gradual putrefaction and decay, than to cut and take them off for the purpoſe of being by other means converted into manure. It ſeems likewiſe probable, on the ſame grounds, that for the production of crops of bulbous-rooted vegetables on the more ſtiff and tenacious ſoils, the matters made uſe of as manures may be employed with the greateſt advantage, when put into the earth before they have undergone any great degree of decay by means of putrefaction, as in this way there is no waſte, the whole being ultimately converted and applied, though more ſlowly, to the ſupport of the crops.

As to the ſeaſon in which manures may be put into the ſoil, or ſpread out upon its ſurface, with the greateſt benefit and advantage, though in practice it muſt, in ſome meaſure, depend on the ſtate of the land and the convenience of the farmer, it ſhould, in caſes where they are buried in the ground, be as nearly as poſſible to the periods in which the ſeeds or the roots, which they are deſigned to ſupport, are ſown or placed in the earth; and in the latter caſe, or where they are to be laid upon the ſurface of the land, it ought probably to

be juſt before the crops of graſs, or other vegetables, begin naturally to ſpring or ſhoot forth.

By the practice of depoſiting and blending the manure with the ſoil, nearly at the time the crops are put in, there is ſcarcely any waſte of the fertilizing properties of ſuch ſubſtances, which, as they gradually proceed in their decompoſition and decay under the ground, muſt otherwiſe be the caſe, the roots of the plants not being in the moſt proper ſtates for taking them up and converting them to their ſupport. Beſides, in the ſtiff, loamy, or clayey ſoils, they have a tendency, as has been remarked above, to produce a degree of lightneſs and friability that is ſuited to the early proceſs of vegetation. And it is obſerved by an able writer, that "the atmoſpheric air, which is buried along with the manure in the interſtices of the earth, and which for many weeks, or even months, renders the ſoil looſe and eaſily impreſſed by the foot on walking on it, gradually evolves, by its union with carbon, a genial heat, very friendly to vegetation in this climate, as well as the immediate production of much fluid carbonic acid, and probably of a fluid mixture of nitrogen with hydrogen, which are believed to ſupply much nutriment to plants *."

And by the application of ſuch manures as are employed in the way of top-dreſſings in the beginning of the ſpring, they are laid on in the moſt favourable period for affording their nutritious principles, and for their being drank up by the roots of plants, conſequently become uſeful at the time they are moſt wanted for the promotion of the crops, and the great waſte which muſt otherwiſe be cauſed, either by the exceſſive falls of rains and floods in the winter ſeaſon, waſhing down much of the valuable properties into the adjoining rivers and ditches, or the evaporation of their more volatile or elaſtic matters by means of the ſummer heats, is moſt effectually guarded againſt and prevented.

The practice common in ſome places of applying manure to graſs lands in the latter end of ſummer or beginning of autumn, after the firſt crop of hay has been taken from the ground and the after-graſs has begun to make ſhoots, is not by any means ſo favourable as that of early ſpring, as in the latter caſe the generation of thoſe materials that contribute to the ſupport of vegetation is greatly promoted by the conſtantly increaſing heat of the vernal and ſummer months; while in the former it is conſtantly checked and retarded by the increaſing coldneſs of the autumn and winter ſeaſons. Beſides, the manure, by being ſpread out upon the ſurface of the land, under ſuch circumſtances, muſt be the cauſe

* Darwin's Phytologia, p. 251.

of great loſs, by contaminating the after-graſs, and rendering it incapable of being eaten off by cattle or other kinds of live ſtock.

Where, however, a ſecond crop of hay is to be taken, it may ſometimes be put on at ſuch times with advantage to ſuch crop, eſpecially if the weather be not too hot, and the manure in a perfectly fine and reduced ſtate.

Doctor Fenwick, in his very ingenious reflections on manures, has very well obſerved, that it is ſcarcely poſſible to ſuggeſt a worſe mode of uſing manures on graſs lands, than that which is almoſt univerſally practiſed in the neighbourhood in which he reſides; and it is the ſame in many other parts of the country, as is evident from the reports that have been lately publiſhed under the authority of the Board of Agriculture: "When a ſevere froſt has bound up the land in a ſtate of impenetrable coheſion, the farmers," ſays he, "wheel on their dung, perhaps even when ſnow has covered it. While the froſt laſts the land can derive no advantage from the manure, and when a thaw ſupervenes it is evident that the waſh from the melting ſnow, or from the rains which generally fall in ſuch weather, muſt deprive the maſs of every part that is ſoluble. The ground, in the mean time, retains the froſt for many days, and is therefore incapable of abſorbing the wet which falls upon its ſurface; and even when the influence of the milder air has reached it, it can imbibe but little, being in general previouſly filled with water, and the quantity which flows over it being too great for ſoil under any circumſtances to drink up*."

In favour of this deſtructive and waſteful practice, however much it may have been defended on the ground of the farmer's leiſure or convenience, and the little injury done to the turf or ſward of the land, the ſame writer thinks there can be only one reaſon alleged, which is, that manure, when ſpread early in the winter, may protect the roots of graſſes from the ſeverity of froſts. This too is probably a miſtaken notion, as it is known to every one, that the common graſſes are ſeldom injured by the ſevereſt froſts; and other kinds of graſſes may probably not ſuffer leſs injury from the application of manure at ſuch a ſeaſon, than from the ſeverity of froſts.

On all theſe accounts, therefore, farmers ſhould contrive as much as poſſible to apply the manures, intended as top-dreſſings to graſs lands, as early in the ſpring as it can be conveniently done, which may be eaſily managed on thoſe that are dry, and on ſuch as are inclined to be wet and poachy, it may probably be greatly facilitated by having ſmall light carts conſtructed for the purpoſe, and placed on broad cylinders as wheels. We are fully convinced, from the trials

* Fenwick's Reflections on Manures, p. 23.—Newcaſtle.

which we have made in applying manures to grafs lands at fuch periods, that the trouble of the farmer will not only be rewarded by much larger crops of hay, but alfo by a confiderable increafe in the quantity of the after-grafs; and, befides, his crops in both inftances will be more forward than in the ordinary methods of putting them on, either in the autumn or the winter months, which in many cafes is a circumftance of great importance.

In the application of manures to lands under tillage, as well as thofe in the ftate of grafs, there are a few other circumftances that require the attention of cultivators; fuch as the depth they may be depofited in the foil, the modes of putting them upon the ground, and the moft economical methods of employing them.

As we have already feen that the putrefaction and decay of animal and vegetable matters, whether above or beneath the ground, is greatly promoted by the free admiffion of air and a fuitable degree of moifture to them, it is evident that they fhould not be buried fo deep in the earth, as that they may be prevented from readily receiving the aid of fuch caufes in forwarding their decompofition; nor, as the procefs is known to be much retarded by the fubftances being rendered too dry, fhould they be placed fo near the furface, or be fo thinly covered, as to permit the action of the fun and winds, before the crops have rifen to fuch heights as to prevent it, from diffipating and carrying away their nutritious properties. The introduction of the manure to a middling depth, as three or four inches, would, therefore, on thefe accounts, as well as from its contributing more expeditioufly and more fully to the vegetation of the crops that may be put in with it, feem, in general, to be the moft advantageous practice; but on the lighter and more friable foils, it may be advifable to plough it into a greater depth than in fuch as are heavy and tenacious. In every cafe, however, whether the manure made ufe of be in a long or a more reduced ftate, it fhould be perfectly covered or ploughed into the earth. The practice of burying manures deep in the foil, has been defended by fome on the ground of its being the nature of elaftic matters to rife or force themfelves towards the furface; but when they are placed to a confiderable depth in the earth, as the procefs of decompofition is thereby ftopped, or fuffered to proceed in but a very flow and feeble manner, little or nothing efcapes for the fupport of vegetation, or it is furnifhed in fo very flow and fparing a way, as to be of fcarcely any fervice to the immediate crops. Thus in the cultivation of fuch crops as are placed in rows or drills, where the manure is put into a great depth and covered pretty thickly with earth, on digging them up at the end of many months it may frequently be obferved nearly in the fame ftate it was when firft put into the ground. And the fame thing is often noticed by gardeners, where imperfectly reduced or long

dung is placed in deep trenches and covered to a conſiderable thickneſs with mould.

In order that manures may produce their effects in the moſt perfect manner, they ſhould be ſpread over the ſurfaces of the grounds as evenly as poſſible, whether they be intended to be turned into the ſoil or left upon its ſurface as top-dreſſings. This may be greatly facilitated by placing the manures out at firſt in very ſmall heaps, as by ſuch a practice it may be ſpread over the ground with much greater eaſe and exactneſs; and on graſs lands much leſs injury will be done by the bottoms of the heaps.

On tillage lands, manures ſhould always be turned in, or otherwiſe covered, as ſoon as poſſible after they are ſpread out; for if this be neglected, much loſs may be ſuſtained, eſpecially in hot ſeaſons, by the quick evaporation that takes place in ſuch caſes. The beſt practice is therefore not to carry more out from the dunghill at a time than can be conveniently ſpread upon and ploughed into the earth in a ſhort time afterwards. In ſpreading manures employed as top-dreſſings on graſs lands, much advantage will be gained by breaking and reducing the clods or lumps into as fine a ſtate as poſſible, as by ſuch means they are not only applied more perfectly, but waſhed by the rains much more readily to the roots of the graſſes. The ſpringing of the young graſſes is alſo leſs retarded where the manures are rendered fine and powdery, than where they are left in a cloddy ſtate.

In the uſe of manures, it ſeems not improbable but that ſome degree of ſaving may occaſionally be made, as has been already recommended, by applying them on lands under tillage, as well as others, nearly at the time the ſeeds and roots are put into the ground, or when the graſſes begin to ſhoot; as from the whole of the manure being in this way made to contribute directly to the ſupport of the crops, a leſs quantity may be ſufficient for the purpoſe: how far they may be ſafely diminiſhed on this principle, can only be ſhewn by actual experiments and accurate deductions made from them; but there are ſufficient grounds, from what has been obſerved, for ſuppoſing that it may be conſiderably more than can be eaſily apprehended by thoſe who have not adverted much to this circumſtance.

Another economical mode of employing manure is, by placing it in the drills or hollows formed for the reception of different crops which are cultivated in rows, as peas, beans, cabbages, potatoes, &c.: by this method, that part of the ground which is intended to bear the crop is only manured, the intervals or ſpaces between the rows not receiving any, from which, where the buſineſs

of putting the manure into the drills is properly performed, a great ſaving muſt of courſe be made. According to the concluſions of a later writer, the ſaving of manure in this way is ſo great as to conſtitute one of the chief advantages of the drill ſyſtem of cultivation. His calculation is, that by "drills being made two feet aſunder, and each drill ſix inches wide at the bottom, there will be juſt one fourth part of the ground covered with manure; for as ſix inches, multiplied by four, gives two feet, which will be the diſtance from drill to drill, and as four multiplied by four makes ſixteen, it follows, that if the whole of the land had been covered with manure, ſixteen loads would have been required for what is as fully and beneficially performed by four, that is by one quarter of the quantity uſed by the old method of dreſſing, ſuppoſing it of the ſame thickneſs and quality *." Beſides, from the manure being in this method kept cloſely together, and the ſeeds or plants placed immediately upon it, they muſt, he ſuſpects, receive the advantage of the dreſſing in a more full and complete manner.

As it appears probable that in the decay of different materials in the ſoil, all the nutritious matters as they are formed immediately become uſeful for the purpoſe of vegetation, without any waſte being ſuſtained, as muſt always be more or leſs the caſe where they are depoſited together in heaps, it may be an economical practice, as has been already obſerved, in caſes where the crops to be benefited by them require a regular and laſting but not large ſupply of nouriſhment, or where the ground is required to be kept in an open and rather light ſtate, for a conſiderable length of time, to employ ſuch manures in their leſs decompoſed ſtates, as by the ploughing down of green ſucculent vegetable crops, and the turning in of long ſtrawy ſubſtances.

By adopting ſuch means, the more perfectly formed manures of the farm may be reſerved for ſuch crops of luxuriant vegetables as demand more ſpeedy and abundant ſupplies of nutrient matters.

In reſpect to the advantage of uſing one ſort of manure in preference to another, it may be obſerved, that as animal matters are found in general to undergo more ſpeedily the proceſs of putrefaction or decompoſition, than thoſe of the vegetable kind, and as in moſt inſtances they afford thoſe mucilaginous and elaſtic principles that contribute ſo largely to the ſupport of vegetable life in greater proportions; ſuch manures as are either wholly or in a great meaſure compoſed of them, muſt be the moſt beneficially employed, where quick and

* Experienced Farmer, vol. II.

abundant ſupplies of nouriſhment are required, as in the growth of all the more groſs and luxuriant crops, whether of grain, plants, or graſſes; and that as thoſe vegetable ſubſtances which contain ſaccharine, farinaceous, oily, ſaline, or mucilaginous principles in the largeſt quantities are aſcertained from experience to proceed the moſt readily into the ſtate of diſſolution or decay, and conſequently to afford more fully and more expeditiouſly the nutrient food of new plants, where manures are principally formed from them, they ſhould be preferred to ſuch as have been made from the harder and more ligneous vegetable ſubſtances, that contain ſuch properties in ſcarcely any, or much ſmaller degrees, for all the purpoſes of agriculture.

And laſtly, ſuch ſubſtances as are found to contain thoſe elementary materials, of which vegetables are principally conſtituted in their more ſoluble or looſely combined ſtates, as carbonaceous matter in the black earths or moulds, and oxygen, azote, and hydrogen, in burnt clay, raddle*, manganeſe, and calamy, ſubſtances which have hitherto been little employed, as well as in water and air, ſhould be made uſe of in preference to thoſe which poſſeſs them in ſlight proportions or ſcarcely at all.

The moſt convenient and advantageous modes of applying particular kinds of manures have been ſo fully conſidered, in the preceding parts of the ſection, that nothing further ſeems neceſſary to be added here in reſpect to them.

* Raddle, according to the information of Dr. Darwin, has lately been uſed with advantage on ſome lands in the north of Staffordſhire. Phytologia, p. 223.

SECTION VIII.

Draining of Land.

MUCH WATER neceſſary to the healthy Growth of Plants—Highly injurious to, when retained in or upon, Soils in over Proportions—Hence the Neceſſity of removing it, by draining ſuch Lands previouſly to other Improvements—Circumſtances on which the ſucceſsful Performance of this Buſineſs depends—The different ſtratified Nature of the Ground to be attended to—Diſtinction of the Strata in different Caſes—In Elevations or Hills—In lower Grounds—Reaſon of their Irregularity in different Inſtances—Manner in which Water is formed and collected on elevated Situations and brought down to the lower ones—Different watery Appearances produced thereby, as Swamps, Moraſſes, oozing Springs, weeping Rocks, large Springs, Rivulets, &c.—Break out at different Diſtances, according to the Nature and Regularity of the Stratum on which the Water paſſes—On what the difference of Force depends in different Caſes—Nature of the impervious Strata on which the Water is conducted—Clayey and compact marly Strata chiefly the Kinds on which Water is conveyed—They extend to different Depths in different Caſes—The clayey generally the more ſuperficial—Nature of the intervening porous Materials, in different Caſes—Different Situations of Ground in reſpect to Wetneſs—Methods of removing it in different Caſes and Situations of Land—Circumſtances to which Attention ſhould be paid in this View—Cauſes from which Wetneſs as reſpecting Agriculture moſtly ariſes—General Methods of removing by intercepting the Water of Springs—Different Caſes of—By cutting of Drains—By perforating by Means of the Auger—Caſes where the common Method of cutting various deep Drains may be practiſed with Succeſs—Where perforating the thin impervious Strata to the open porous ones may be made Uſe of—Circumſtances that tend to ſhew the Preſence of Springs—Caſes in which Water may be intercepted by cutting into the Sides of elevated Grounds, and carried off by ſuitable Means at high Levels—Drainage of Lands lying below the Level of the Sea only to be effected by expenſive Machinery—Encircling them with large Ditches might be beneficial—Surface Wetneſs, from the retentive Nature of Soils and Peculiarity of Situation, removed by hollow ſuperficial Drains properly formed—In graſs Land—In arable Land.—PRACTICAL METHODS of proceeding in the Drainage of wet boggy Lands—Circumſtances on which it depends in different Caſes of—Manner of Levelling for—Different Directions of the Strata produce Differences in—Means of aſcertaining the principal Spring in cutting Drains in—Effects of cutting them improperly in—Cutting in Caſes of irregular Banks—Mode of draining in narrow confined Bogs, where the porous Stratum containing the Water unites at but little Depth below the retentive Material—In thoſe of a more extenſive Kind—In marſhy or hollow Lands adjoining Rivers—Modes of forming the Drains in theſe Caſes—Kinds of moſt uſeful in—Sorts of Materials employed in filling them—Nature of Bricks uſed in conſtructing them—What requiſite to be attended to in putting in the Earth afterwards—Signs of Stoppage of

—Mouth of Drains to be guarded—Circumſtances which ſhew the Drains to be effectual—Method of Drainage where the under Stratum is porous, different from that of theſe juſt deſcribed—Drains to be made in the moſt depending Parts through the upper ſurface Soil to the retentive Stratum—Boring then neceſſary to let down the Water—Same Purpoſe effected by deep Pits or Wells—Drains in theſe Caſes to be made narrow and filled with Stones—Attention neceſſary in forming the Ridges when the Land is to be in Tillage—Nature of porous Stratum firſt to be aſcertained—Drainage of Hills or elevated Paſture-grounds, what neceſſary to be attended to in—Drains made according to the Poſition of the Strata—Trenches neceſſary to be formed high up in the wet Soil to intercept the Springs—Other Cuts lower down requiſite in ſome Caſes—Both Sides of Hills may often be drained by cutting into the drier—Houſes conveniently ſupplied with Water in ſuch Caſes—May ſometimes be raiſed to a great Height in—The Cuts or Bores not to be made too deep in theſe Caſes—Method of Drainage where the Soil is formed of alternate Beds of Clay and Sand—Reaſon why more generally expenſive in—Manner of cutting the Drains in---Means of aſcertaining the beſt Situation for---Modes of draining in ſeveral Varieties of, deſcribed---Reaſon why the Drains ſhould be cut in an horizontal Direction---Fewer Drains neceſſary in theſe Soils---Cauſe of explained---Mode of Drainage where the Soil is porous above and retentive below, or the contrary---Methods of forming the Drains in the different Caſes of---By the Spade—By the Plough---Modes of filling them in---Implements made uſe of in cutting them---Beſt Seaſon for making them---Size of in different Inſtances---Much effected in ſuch Caſes by proper Conſtruction of Ridge and Furrow Expence and Duration of in different Caſes---Method of Drainage in Mines, Quarries, Marle, and other Pits ---Circumſtances to be attended to in different Caſes—By cutting off the Springs---By letting the Water down into the porous Stratum below---Uſes to which Water may be converted in ſome Inſtances of this Kind---Obſervations on Draining in general.

ALTHOUGH it has been clearly ſhewn by the various experiments and obſervations that have been made on the nature of vegetation, that a large proportion of water is eſſentially neceſſary for the ſupport of the healthy growth of plants, and which will be ſtill further explained in ſpeaking of the application of it to graſs lands; it is evident that it may exiſt in ſuch over-quantities, or be ſo retained in or upon the ſoil, as to prove not only highly injurious to the growth of the crops, whether of grain or graſs, but likewiſe prejudicial to the health of thoſe who inhabit the diſtricts where it is ſuffered thus to become ſtagnant. It therefore becomes the buſineſs of the farmer, in ſuch caſes, to attempt the removal of thoſe prejudicial exceſſes of moiſture, before he commences any other operations for the purpoſe of improving ſuch lands; as without fully accompliſhing this object, in the firſt inſtance, all his future exertions will be of but little avail. This may, in moſt inſtances, be accompliſhed by means of draining, a practice the ſucceſsful execution of which, in a great meaſure, de-

pends on a proper knowledge of the ſtructure of the earth, and of the various ſtrata of which it is compoſed, as well as of their relative degrees of poroſity or capability of admitting or rejecting the paſſage of water through them, and likewiſe the modes in which water is formed and conducted from the high or hilly ſituations to the low or level grounds. In whatever way the hills or elevations that preſent themſelves on the ſurface of the globe were originally formed, it has been clearly ſhewn, by ſinking large pits, and digging into them, that they are moſtly compoſed of materials lying in a ſtratified order, and in oblique or ſlanting directions downwards; ſome of which ſtrata, from their nature and properties, are capable of admitting water to percolate or paſs through them, while others do not allow it any paſſage, but force it to run or filtrate along their ſurfaces without penetrating them in any degree, and in that way to conduct it to the more level grounds below, till it becomes obſtructed or dammed up by meeting with impervious materials of ſome kind or other, when it is readily forced up into the ſuper-incumbent layers where they happen to be open and porous, ſoon rendering them too wet for the purpoſes of agriculture: but where they are of a more tenacious and impenetrable quality, they only become gradually ſoftened by the ſtagnant water below them; by which the ſurface of the ground is, however, rendered equally moiſt and ſwampy, though ſomewhat more ſlowly, than in the former caſe. It may alſo be obſerved, that ſome of the ſtrata which conſtitute ſuch hilly or mountainous tracts are found to be continued with much greater regularity than others; thoſe which are placed neareſt to the ſurface at the inferior parts of ſuch hills, or elevations, being moſtly broken or interrupted before they reach the tops or higher parts of them, while thoſe which lie deeper, or below them at the bottom, ſhew themſelves in theſe elevated ſituations. Thus, that ſtratum which may lay the third or fourth, or ſtill deeper, at the commencement of the valley, may be the moſt ſuperficial, or form the uppermoſt layer, on the ſummits of hills or mountainous elevations. This arrangement or diſtribution of the different ſtrata may have been produced partly by the circumſtances attending the original elevation of ſuch mountainous regions, and partly from the materials of the original exterior ſtrata being diſſolved and carried down into the valleys by ſucceſſive rains, and other cauſes, and thus leaving ſuch as were immediately below them in an expoſed and ſuperficial ſtate in theſe elevated ſituations *.

* See Darwin's Phytologia, p. 258.

But in whatever way or from whatever cauſes it may have happened, that thoſe ſtrata which are placed at conſiderable depths at the bottoms of hills, and other more elevated regions, preſent themſelves and become ſuperficial upon their ſummits, it is evident that they frequently prove the means of rendering the grounds below wet and ſwampy: for, from the night dews, and the general moiſture of the atmoſphere, being condenſed in much greater quantities in ſuch elevated ſituations; from their greater coldneſs, or other cauſes, than in thoſe level ſurfaces which are below *; the water thus formed, as well as that which falls in rain and ſinks through the ſuperficial porous materials, readily inſinuate themſelves, and thus paſſes along between the firſt and ſecond, or ſtill more inferior, ſtrata which compoſe the ſides of ſuch elevations, until their deſcent is retarded or totally obſtructed, as has been juſt ſhewn, by ſome impenetrable ſubſtance, ſuch as clay; it there becomes dammed up, and ultimately forced to filtrate ſlowly over it, or to riſe to ſome part of the ſurface, and conſtitute, according to the particular circumſtances of the caſe, different watery appearances in the grounds below; ſuch as oozing ſprings, bogs, ſwamps or moraſſes, weeping rocks from the water ſlowly iſſuing in various places, or a large ſpring or rivulet from the union of ſmall currents beneath the ground. This is obvious from the ſudden diſappearance of moiſture on ſome parts of lands, while it ſtagnates, or remains till removed by the effects of evaporation, on others; as well as from the force of ſprings being ſtronger in wet than dry weather, breaking out frequently after the land has been impregnated with much moiſture in higher ſituations, and as the ſeaſon becomes drier ceaſing to flow, except at the loweſt outlets. The force of ſprings, or proportion of water which they ſend forth, depends likewiſe, in a great meaſure, on the extent of the high ground on which the moiſture is received and detained, furniſhing extenſive reſervoirs or collections of water, by which they become more amply and regularly ſupplied. On this account, what are termed bog-ſprings, or ſuch as riſe in valleys and low grounds, are conſider-

* It is obſerved by Dr. Darwin, in the firſt volume of his Botanic Garden, p. 485, additional note xxvi. that the loweſt ſtrata of the earth appear on the higheſt hills; that ſprings are formed from dews ſliding between them; that mountains are colder than plains; 1. from their being inſulated in the air; 2. from their enlarged ſurface; 3. from the rarity of the air it becomes a better conductor of heat; 4. by the air on mountains being mechanically rarefied as it aſcends; 5. gravitation of the matter of heat; 6. the daſhing of clouds againſt hills; of fogs againſt trees; ſprings ſtronger in hot days with cold nights; ſtreams iſſue from ſubterranean caverns; from beneath the ſnow on the Alps.

ably ſtronger and more regular in their diſcharge, than ſuch as burſt forth on the more elevated ſituations or the ſides of eminences *.

The waters condenſed in the manner deſcribed above on the tops of elevated regions, are ſometimes found to deſcend, for a very conſiderable diſtance, among the porous ſubſtances between the different conducting layers of clayey or other materials, before they break out or ſhew themſelves in the grounds below; but it is more frequently the caſe to find them proceeding from the contiguous elevations into the low grounds that immediately ſurround them.

The nature and regularity of the ſtratum of materials, on which the water proceeding from the ſummits of hills has to filtrate and ſlide upon, muſt conſiderably influence its courſe, as well as the effects which it may produce on ſuch lands as lie below and into which it muſt paſs: as where it is of the clayey, ſtiff marly, or impervious rocky kinds, and not interrupted or broken by any other kind of materials of a more porous quality, it may paſs on to a much greater diſtance, than where the ſtratum has been frequently broken and filled up with looſe porous materials, in which it will be detained, and of courſe riſe up to the ſurface.

It is for the moſt part on the clayey, ſtiff cloſe marly, and unfractured ſtony ſtrata, that water is conducted from the hills and more elevated grounds into the plains and valleys which are below them.

Theſe ſorts of ſtrata extend to very different depths in different ſituations and diſtricts, as has been frequently noticed in the digging of pits, and the ſinking of deep wells, and other ſubterraneous cavities. The clayey ſtrata are, however, in general found to be more ſuperficial than thoſe of the compact, tenacious, marley kinds, or even thoſe of a firm, uninterrupted, rocky nature, and ſeldom of ſuch a great thickneſs; they have, nevertheleſs, been obſerved to vary greatly in this reſpect, being met with in ſome places of a conſiderable thickneſs, while in others they ſcarcely exceed a few inches.

The intervening porous ſubſtances or ſtrata where clay prevails are found, for the moſt part, to be of either a gravelly or looſe rocky nature. Stiff marly ſtrata, which approach much to the quality of clay, though in ſome inſtances they may preſent themſelves near the ſurface, in general lie concealed at conſiderable depths under the true clayey, and other layers of earthy or other materials: they have been diſcovered of various thickneſſes, from eight or ten feet

* See Johnſton's Account of Elkington's Mode of Draining Land, p. 15.

to conſiderably more than a hundred *. The intervening materials, where ſtrata of this nature are predominant, are moſt commonly of the more ſandy kinds, poſſeſſing various degrees of induration, ſo as in ſome caſes to become perfectly hard and rocky, but with frequent breaks or fiſſures paſſing through them. The looſe, friable, marly ſtrata are capable of abſorbing water, and of admitting it to filtrate and paſs through them.

It may be concluded from this view of the nature and arrangement of the various ſtratified materials that conſtitute the earth, and the manner in which water is formed on the more elevated and hilly ſituations, and brought down from them, that the valleys and more level grounds below muſt conſtantly be liable to be overcharged with moiſture, and, as has been already ſhewn, to become in conſequence of it ſpouty, boggy, or of the nature of a moraſs, accordingly as they may be circumſtanced in reſpect to their ſituation, the nature of their ſoils, or the materials by which the water is obſtructed and detained in or upon them.

Where lands have a ſufficient degree of elevation to admit of any over-proportion of moiſture readily paſſing away, and where the ſoils of them are of ſuch an uniform ſandy or gravelly and uninterrupted texture, as to allow water to percolate and paſs through them with facility, they can be little inconvenienced by water coming upon or into them, as it muſt of neceſſity be quickly conveyed away into the adjacent rivers or ſmall runlets in their vicinity.

But where grounds are in a great meaſure flat, and without ſuch degrees of elevation as may be ſufficient to permit thoſe over-proportions of moiſture that may have come upon them from the higher and more elevated grounds, either in the way that has been ſhewn above, or from the overflowing of rivers and ſmaller ſtreams of water that may paſs through or near them, and from the falling of heavy rains, to readily paſs away and be carried off; and where the ſoils of the lands are compoſed or conſtituted of ſuch materials as are liable to admit and retain the exceſſes of moiſture that may in any of theſe ways come upon them; they muſt be expoſed to much injury and inconvenience from the retention and ſtagnation of ſuch quantities of water, and conſequently require artificial means to drain and render them capable of affording good crops, whether of grain or graſs: and, laſtly, lands of valleys and other low places, as well as, in ſome caſes, the level tracts on the ſides or borders of large rivers and of the ſea, from the peculiarity of their ſituations, and their being compoſed in a great meaſure of porous or ſpongy materials, formed by the diſſolution and de-

* See Darwin's Phytologia, p. 259.

cay of various coarſe vegetable and other matters, which are produced on them, or which have been gradually, for a vaſt length of time, waſhed down and brought into them from the hills and riſing grounds by rains and other cauſes, or depoſited by means of floods, ſo as to form different degrees of accumulation, according to the difference of ſituation or other circumſtances, muſt alſo frequently be ſubject to great injury and inconvenience from their imbibing and retaining the water that may be thus forced to flow up into or upon them, either through the different conducting ſtrata from the hills and mountainous elevations in the neighbourhood, or the porous materials of the ſoils; as in theſe ways they may, as we have already ſeen, be rendered ſwampy, and have bogs or moraſſes produced in them in proportion to the predominancy of the materials by which the water is abſorbed and dammed up, and the peculiarity of the ſituation of the lands in reſpect to the means of conveying it away.

On theſe grounds, beſides a knowledge of the nature and inclination of the various ſtrata that compoſe the interior parts of the earth, it is clear that, in order to properly perform the buſineſs of draining, attention ſhould not only be paid to the diſcrimination of the differences in regard to the ſituation of the lands, or what is commonly denominated drainage level, but alſo to the nature, diſtribution, and depth of the materials that conſtitute the ſoils or more ſuperficial parts of them, as upon each of theſe ſome variety in reſpect to the effects ariſing from water retained in them may depend.

But though there may be conſiderable diverſity in the effects which water produces in or upon lands from theſe different cauſes, wetneſs of land, ſo far as it reſpects agriculture, and is an object of draining, may generally depend on the two following cauſes: firſt, on the water which is formed and collected on or in the hills or higher grounds, in the manner which has been explained, filtrating and ſliding down among ſome of the different beds of porous materials that lie immediately upon the impervious ſtrata, forming ſprings below and flowing over the ſurface, or ſtagnating underneath it; ſecondly, on rain or other water becoming ſtagnant on the ſurface, from the retentive nature of the ſoil or ſurface materials, and the particular nature of the ſituation of t e ground. The particular wetneſs which ſhews itſelf in different ſituations, in the forms of bogs, ſwamps, and moraſſes, for the moſt part proceeds from the firſt of theſe cauſes; but that ſuperficial wetneſs which takes place in the ſtiff, tenacious, clayey ſoils, with little inclination of ſurface, generally originates from the latter.

From the ideas which have been ſuggeſted reſpecting the nature and formation of the different ſtrata that compoſe the earth, and of the manner in which

water ſlides, filtrates, or paſſes down among or between them, and forms ſprings, which, according to circumſtances, render the grounds below boggy, ſwampy, or too wet for the purpoſes of agriculture, it is evident that the beſt and moſt certain, as well as the moſt expeditious, method of draining, in ſuch caſes, muſt be that of intercepting the deſcent of the water or ſpring, and thereby totally removing the cauſe of wetneſs. This may be done where the depth of the ſuperficial ſtrata, and conſequently of the ſpring, is not great, which may be previouſly known by the uſe of a draining auger, by making horizontal drains of conſiderable length acroſs the declivities of the hills, about where the low grounds of the valleys begin to form, and connecting theſe with others made for the purpoſe of conveying the water thus collected into the brooks or runlets that may be near. And as the ſtrata between which the water paſſes down to produce ſuch ſprings have, for the moſt part, nearly a ſimilarity of inclination with that of the ſurface of the hill or riſing ground, the auger holes of the drains ſhould not, as is the general practice, be made directly downwards, but perpendicularly to the ſurface of the elevation, as in this way the ſtratum on which the water paſſes down may be more readily dug to and the water drawn off*; or where the ſpring has naturally formed itſelf an outlet, it may frequently only be neceſſary to render it larger, and of more depth, which by affording the water a more free and open paſſage may evacuate and bring it off more quickly, or ſink it to a level ſo greatly below that of the ſurface of the ſoil, as to prevent it from flowing into or over it.

But where the ſprings, from the great thickneſs of the upper ſtratum, are confined at ſuch a depth beneath the ſurface as that they injure it, by rendering it conſtantly moiſt, or by imperceptibly oozing through it, but afford no marks of any particular outlets; and where a drain cannot be cut ſo deep as to come to them, either on account of the great difficulty of doing it or the expence that muſt attend it, or where the level of the outlet will not allow of its being cut to that depth; it will be neceſſary, after cutting ditches in the way that has been juſt explained, to perforate the ſoil beneath by means of a boring inſtrument conſiderably deeper, ſo as to reach the ſpring, and thus give free vent to the water collected below;—a method of practice which ſeems long ago to have been ingenioufly ſuggeſted by Dr. Anderſon, and ſince more fully and more particularly applied by Mr. Elkington.

Where this can be effectually accompliſhed, ſuch a number of perforations

* See Darwin's Phytologia, p. 262.

ſhould be made as will allow the confined water to paſs readily into the drains, and be conveyed by the connecting ditches to the adjoining ſtreams of the neighbourhood: in theſe caſes the water coming freely into the drains ſeveral feet below the moiſt ſurface of the land, and being then conducted away, will not be forced up through the ſuperincumbent materials of the ſoil to the ſurface which is ſo much higher *.

As in caſes of this kind, where, after boring in this manner, the water breaks forth with conſiderable violence, it may ſometimes be apt to bring up with it ſuch quantities of ſand, or other ſubſtances, as may block up the holes and prevent the free exit of the water, it may be neceſſary to apply the auger frequently in order to remove it. A ſtriking inſtance of this kind is related in the Philoſophical Tranſactions, where, on the ſinking of a well four feet wide, and 236 feet deep, and then boring ſome feet deeper with a five-inch borer, ſo much ſand was forced up by the impetuoſity of the water that broke forth as to fill the well, and which on being cleared away by buckets in its liquid ſtate, ſuffered the water to flow over the ſurface in the quantity of forty-ſix gallons in a minute.

There may be ſtill other ſituations of lands, as where the uppermoſt ſtratum is ſo extremely thick as not to be eaſily penetrated, or where the ſprings, formed by the water paſſing from the higher grounds, may be confined beneath the third or fourth ſtrata of the materials that form the declivities of hills or elevated grounds, on account of ſo many of them becoming deficient on their tops, or more elevated parts, and by this means lie too deep to be penetrated to by the cutting of a ditch, or even by boring; and ſtill, from the water being obſtructed by the different materials forming the plains below, may be forced up to the ſurface, and produce different kinds of injurious wetneſs †.

In ſuch caſes, the common mode of cutting a great number of drains to the depth of five, ſix, or more feet, acroſs the wet moraſſy grounds, and afterwards covering them in ſuch a manner as that the water may ſuffer no interruption in paſſing away through them, may be practiſed with advantage, as much of the prejudicial exceſs of moiſture may by this means be collected and carried away, though not ſo completely as by fully cutting off the ſpring ‡.

As water is ſometimes found to be conveyed from the hills and high grounds at no great depth beneath the ſurface of the land upon thin layers of clay,

* See Johnſton's Account of Elkington's Mode of Draining Land, p. 17.

† See Darwin's Phytologia, p. 263.

‡ Ibid.

which have underneath them ſand, ſtone, or other porous or fiſſured ſtrata, to a conſiderable depth; by perforating theſe thin layers of clay in different places, the water which flows along them may frequently be let down into the open, porous materials that lie below them, and the ſurface land be thus completely drained*.

* The Author of Phytologia, after ſhewing that from the variety in the direction of the ſtrata of the earth ſprings in ſome eminences of ground are only to be met with on one ſide of the mountain, while in others they may be on all ſides of it, remarks, that in ſearching for them attention ſhould be given to the inclination of the ſtrata of that part of the country, which may be often ſeen in marl-pits, gravel-pits, or in hollow lanes. But they may, he thinks, in general, be found above any moiſt or moraſſy plain or valley, the moiſture of which ſhews that ſprings exiſt in the ſtrata on that ſide of the mountain; and that a ſecond obſervation for the ſame purpoſe may be made on miſty evenings, as thoſe parts of the grounds where the miſt commences are moiſter than thoſe in their vicinity on the ſame level, and in conſequence may, generally, if they are not hollow baſons, poſſeſs ſprings nearer the ſurface: for theſe moiſter parts of the ground, having evaporated more during the day, are become colder on their ſurfaces than the drier ground in their vicinity; and in miſty evenings, which are at the ſame time calm, the ſtationary air over theſe moiſt parts of the ground is alſo more loaded with the evaporated moiſture; and on both theſe accounts theſe moiſter ſituations are liable to ſhew a condenſation of aërial vapour ſooner than other places on the ſame level. And as mountains are colder in proportion to their height, as already explained, the evening miſt ſometimes commences ſooner on them than in the valleys; but is ſeen earlier in theſe ſituations over the moiſter places, if they are on the ſame level with the drier ones, exactly as on the plains or valleys; and may therefore indicate the exiſtence of ſprings, unleſs theſe moiſter places conſiſt of hollow baſons containing water, which if not attended to may, in all ſituations, deceive the obſerver. And that another obſervation for detecting ſprings may be made in rimy mornings; for as moiſt earth is a better conductor of heat than dry earth, the rime will ſooner melt on thoſe parts of the ſoil which are kept moiſt by ſprings under it than on other parts; as the common heat of the earth, which is 48 in this country, will ſooner be conducted upwards in moiſt places to diſſolve the rime on the ſurface. On this account, the rime is frequently ſeen on froſty mornings, when the heat of the air is not much above 32, to lie an hour longer on dry cakes of cow-dung, or on bridges, or planks of wood, than on the common moiſt ground; as the latter much better conducts the common heat of the earth to the incumbent rime, which is in contact with it. But as the heat of the common ſprings in this country is 48, where they exiſt, the rime is ſooner diſſolved, than on the ſtagnant moiſture of bogs or moraſſes. And as the ſprings about Buxton and Matlock, and at Bath and Briſtol, are ſo much warmer than common ſprings, it is highly probable, he ſays, that where theſe waters approach the ſurface of the ſoil, they muſt much ſooner diſſolve the rime on froſty mornings; which may probably be obſerved in ſituations much higher than their preſent apparent ſources; as they ſlide down between the interior ſtrata of thoſe hills, beneath the ſummit of which they are condenſed, from the ſteam of water boiling at great depths in the earth, which riſes up through thoſe perpendicular cleſts of the rocks which were formed at their original elevation.

He likewiſe further remarks, that in the winter months the riſe of ſprings may be detected in moiſt ditches by the preſence of aquatic plants, as of water-creſs, water-parſnip, brook-lime; as in thoſe

In thoſe ſituations of land where moraſſes and other kinds of wetneſſes are formed in ſuch low places and hollows as are conſiderably below the beds of the neighbouring rivers, they may, probably, in many inſtances, be effectually drained by arreſting the water as it paſſes down into them from the higher grounds, by means of deep drains cut into the ſides of ſuch hills and riſing grounds, and after collecting it into them conveying it away by pipes, or other contrivances, at ſuch high levels above the wet lands as may be neceſſary: or where the water that produces the miſchief can by means of drains, cut in the wet ground itſelf, be ſo collected as to be capable of being raiſed by means of machinery, it may in that way be removed from the land.

The drainage of thoſe extenſive tracts of land that in many diſtricts lie ſo greatly below the level of the ſea, can only be effected by the public, and by means of locks erected for the purpoſe of preventing the entrance of the tides, and by windmills and other expenſive kinds of machinery conſtructed for the purpoſe of raiſing the ſtagnant water.

It is well obſerved by a philoſophical author, that it might be a noble work, worthy of the attention of a government that wiſhed to increaſe the quantity of nutriment and conſequent population and happineſs of the country, to employ proper engineers, with labourers, in ſuch numbers as to environ with ditches every moraſſy diſtrict, of whatever extent, as lies below the level of the tides, as the fens of Lincolnſhire and Cambridgeſhire. Such ditches, he further remarks, ſhould be cut at the feet of the adjacent riſing grounds, or of eminences ſurrounded with fens, like iſlands in a lake; ſo as to intercept the wall-ſprings and land-floods, and convey the water thus collected above the level of the moraſs into the ocean.

The ſuperficial wetneſs of lands, which ariſes from the ſtiff retentive nature of the materials, that conſtitute the ſoils and the particular circumſtances of their ſituations, is to be removed, in moſt caſes by means of hollow ſuperficial drains, judiciouſly formed, either by the ſpade or plough, and filled up with ſuitable materials where the lands are under the graſs ſyſtem, and by theſe means and the proper conſtruction of ridges and furrows where they are in a ſtate of arable cultivation.

Having thus explained the manner in which ſoils are rendered too wet for

ditches which become dry in the ſummer theſe plants do not exiſt: and when thoſe ditches with ſprings in them are nearly dry, it may be diſcovered which way the current has formerly deſcended by the direction of the points of the leaves of the aquatic plants as certainly as by a level; an obſervation which he learnt from Mr. Brindley, the great canal-conductor of Staffordſhire.

the purpoſes of agriculture, and ſhewn the principles on which the over-proportions of moiſture may, under different circumſtances, be the moſt effectually removed, we ſhall proceed to the practical methods which are to be made uſe of in accompliſhing the buſineſs in each caſe.

Methods of draining boggy land.—In the drainage of wet or boggy grounds, ariſing from ſprings of water beneath them, a great variety of circumſtances are neceſſary to be kept in view. Lands of this deſcription, or ſuch as are of a marſhy and boggy nature, from the detention of water beneath the ſpongy ſurface materials of which they are compoſed, and its being abſorbed and forced up into them, are conſtantly kept in ſuch ſtates of wetneſs as are highly improper for the purpoſe of producing advantageous crops of any kind. They are, therefore, on this account, as well as thoſe of their occupying very extenſive tracts in many diſtricts, and being, when properly reclaimed, of conſiderable value, objects of great intereſt and importance to the attentive agricultor. Wet grounds of theſe kinds, from the nature of their ſituations, and the modes of draining them, are arranged by a late practical writer under three diſtinct heads: firſt, ſuch as may be readily known by the ſprings riſing out of the adjacent more elevated ground, in an exact or regular line along the higher ſide of the wet ſurface; ſecond, thoſe in which the numerous ſprings that ſhew themſelves are not kept to any exact or regular line of direction along the higher or more elevated parts of the land, but break forth promiſcuouſly throughout the whole ſurface, and particularly towards the inferior parts, conſtituting ſhaking quags in every direction that have an elaſtic feel under the feet, on which the lighteſt animals can ſcarcely tread without danger, and which, for the moſt part, ſhew themſelves by the luxuriance and verdure of the graſs about them; third, that ſort of wet land, from the oozing of ſprings, which is neither of ſuch great extent, nor in the nature of the ſoil ſo *peaty* as the other two, and to which the term *bog* cannot be ſtrictly applied, but which in reſpect to the modes of draining is the ſame *.

In order to direct the proper mode of cutting the drains or trenches in draining lands of this ſort, it will be neceſſary for the operator to make himſelf perfectly acquainted with the nature and diſpoſition of the ſtrata compoſing the higher grounds, and the connection which they have with that which is to be rendered dry. This may in general be accompliſhed by means of levelling and carefully attending to what has been already obſerved reſpecting the formation of hills and elevated grounds, and by inſpecting the beds of rivers, the edges

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 19.

of banks that have been wrought through, and ſuch pits and quarries as may have been dug near to the land *. Ruſhes, alder-buſhes, and other coarſe aquatic

* It is remarked by Mr. Johnſtone, in his intereſting practical account of Mr. Elkington's mode of draining land, that after the principal ſpring, or that from which the others are formed, has been fully determined, it is one of the firſt and moſt important parts of the buſineſs, to aſcertain a line on the ſame level on one or both ſides of it. This is to be done by means of levelling, in which the inſtrument called the *ſpirit-level* may be thus employed. The implement being properly adjuſted, and a ſtaff of about ten feet in length, with a moveable vane or ſight fixed upon the top of it, is to be ſet up in a ſituation between the object from whence the level is to be taken, and that to which it is to be directed, provided the diſtance from the inſtrument to each of them is not too great. The ſituation of it ſhould alſo be no higher than the length of the ſtaff will anſwer, and ſo as it may be ſeen from it both ways: then direct the man with the ſtaff to hold it at the *main ſpring*, or place from whence you mean to carry the drain; and after directing the teleſcope to the ſtaff, and adjuſting it to a level, make a ſign to him to move the ſight up or down, till it be exactly oppoſite the croſs hair in the teleſcope. This done, without ſhifting the inſtrument from its firſt poſition, and cautioning the man to fix the ſight to the ſtaff at the point directed, he may proceed forty or fifty yards further; and after having again adjuſted the level, make a ſign to him to move to *higher* or *lower* ground, till the ſight on the ſtaff coincide exactly with the croſs hair in the teleſcope. He may then leave a peg at the place where he held the ſtaff, and proceed, in like manner, to other ſtations, till the whole line is finiſhed, leaving pegs, or making pits, at the places where the ſtaff was held. If the length of the line to be levelled requires the inſtrument to be ſhifted from its firſt poſition, the level muſt again be taken from the laſt ſtation where the ſtaff was held, and the ſight on it fixed in the proper place, as before directed, proceeding in the ſame manner at every forty or fifty yards in length, till the whole is accompliſhed. After the line is thus levelled, and aſcertained by marks left at every ſtation where the ſtaff was fixed, it may again be examined, and other pegs put in between the firſt, the better to direct the workmen in cutting the drain, giving the line ſuch turnings and even ſmall deviations from the courſe of the level, as may ſhorten or ſtraighten it, and humour the ſituation of the ground. For the ſake of accuracy, where the work requires it, eſpecially if the water is to be conveyed any conſiderable diſtance, or wanted to ſupply a houſe, or for the purpoſe of irrigation, the levels, it is obſerved, may be proved by reverſing the former line of direction. The ſpirit-level is alſo, it is remarked, neceſſary for aſcertaining how ſuch fall can be obtained from the drain to the neareſt outlet where the water can be diſcharged, the ſhorter that diſtance being the better, provided fall enough can be had.

It is further ſtated, that it is often neceſſary to level a much longer diſtance than the length of the drain may require to be cut; but when the level of the whole line is known, and the nature of the ground carefully examined, ſhort drains can be cut on that line with openings (places not dug out) between, which will anſwer the purpoſe equally as well as one the whole length; and the expence will be conſiderably leſs, provided the length of the conductors for the water from each be leſs than that of the openings or places not cut: but if the whole line, with only one conductor, be ſhorter than theſe, it is better to have all the water diſcharged at one orifice. The level has frequently to be taken from a ſpring or well, at a conſiderable diſtance from the ground to be drained.

There is, likewiſe, another kind of level, which, from its having been made uſe of in America, and deſcribed by Dr. Edwards, is frequently known by the title of the *American level*, that is extremely uſeful in determining the levels of drains and water-courſes; the conſtruction and mode of applying which

plants, may alſo, in ſome inſtances, ſerve as guides in this buſineſs, but they ſhould not be too implicitly depended on, as they may be cauſed by the ſtagnation of rain-water upon the ſurface, without any ſpring being preſent.

Where the impervious ſtratum, that lies immediately beneath the porous, has a ſlanting direction through a hill or riſing bank, the ſurface of the land below that level will, in general, be ſpongy, wet, and covered with ruſhes on every ſide; while the higher ſide of it will be found to deviate very ſlightly from a level in any part round it. In this caſe, which is not unfrequent, a ditch or drain, properly cut on one ſide of the hill or riſing ground, may remove the wetneſs from both, as ſhewn in the plan *.

But where the impervious ſtratum dips or declines more to one ſide of the

is thus ſtated by the author firſt mentioned: "It is," ſays he, "formed of two pieces of thin wood, of equal length, joined together at top, and connected below by a croſs bar. From the angle at top, a lead plummet is ſuſpended by a ſmall cord, which, when the inſtrument ſtands level on both legs, ſtrikes upon a mark in the centre of the connecting bar;" which may be better underſtood by conſulting the annexed plate.

The manner of uſing it is, he obſerves, ſimply this: "at the place, from whence the level is to be taken, drive a wooden peg into the ground, cloſe in to the top, upon which one of the legs of the frame may reſt; then bringing round the other leg till it touch the ground, there drive in a ſecond peg, and the ſpace betwixt them will be level. In proceeding forward, reſt the leg of the frame upon the top of the ſecond peg, turning round the other leg as before; and where it touches the ground again drive in another peg, and ſo on along the whole line to be levelled. Thus," he ſays, "with very little trouble, and with as much accuracy as with the fineſt ſpirit-level, will the courſe of the drain be eaſily aſcertained. But as it is neceſſary that the drain ſhould have as much declivity as to allow the water to run freely, it will be requiſite, in taking the level, to regulate the direction of the line accordingly: half an inch fall in the length of the frame will be ſufficient." For this purpoſe, it is obſerved, it will be expedient to have, beſides a number of wooden pegs, one iron pin with inches and halves marked regularly upon the ſides of it, from the top downwards. After having drove in the firſt wooden peg at the point from whence you mean to conduct the drain, and having reſted the one leg of the frame upon it, turn round the other till it be level with the firſt peg; there put in the iron pin, ſo that this leg of the frame may reſt on the top of it when level; then drive in a wooden peg ſo far, as that the top of it may be one half-inch lower than that of the iron pin. Place the leg of the frame again upon this ſecond peg, turn it round to a level, putting in the iron pin till the top of it be equal with the foot of the frame; then drive in another wooden peg cloſe by the ſide of it, till the top of the wooden one be half an inch lower than that of the iron pin. Proceed in this manner ſo far as you mean to carry the drain, which will have the ſame degree of declivity all the way along. A line thus ſet off is marked from A to D in the repreſentation. It is remarked, that when made on a ſmaller ſcale, it is uſeful in aſcertaining the proper deſcent along the bottom of the drain, while the workmen are laying it, but that when made for this purpoſe, the croſs-bar muſt be fixed to the bottom of the legs, as marked with dotted lines in the repreſentation.

* See Johnſtone on Draining Land, p. 85.

hill or elevation than the other, the water will be directed to the more depreſſed ſide of that ſtratum; the effect of which will be, that one ſide of ſuch riſing ground will be wet and ſpongy, while the other is quite free from wetneſs *.

In the practical management of draining land, it will be neceſſary after this to determine which of the places at which water iſſues forth on the ſurface, if there be more than one, is the real or principal ſpring, and that from which the other outlets are fed, as upon this muſt depend the direction of the ditch or drain, as by removing that the others muſt of courſe be rendered dry. When on the declivity or ſlanting ſurface of the elevated ground from which the ſprings break forth, they are obſerved to burſt out at different levels according to the difference of the wetneſs of the ſeaſon, and where thoſe that are the loweſt down continue to run, while the higher ones are dry, it is, in general, a certain indication that the whole are connected, and proceed from the ſame ſource; and conſequently that the line of the drain ſhould be made along the level of the lowermoſt one, which, if properly executed, muſt keep all the others dry. But if, as has been the too frequent practice, the drain was made along the line of the higheſt of the outlets or places where the water breaks forth, without being ſufficiently deep to reach the level of thoſe below, the overflowings of the ſpring would merely be carried away, and the wetneſs proceeding from that cauſe be removed; while the main ſpring, ſtill continuing to run, would render the land below the level of the bottom of the drain ſtill prejudiciouſly wet, from its diſcharging itſelf lower down over the ſurface of the ground. Thus, ſays the author mentioned above, it was the cuſtom, until Mr. Elkington ſhewed the abſurdity of the practice, for drainers to begin to cut their trenches whereever the higheſt ſprings ſhewed themſelves between the *wet* and the *dry* ground, which not being of a depth ſufficient to arreſt and take away the whole of the water, others of a ſimilar kind were under the neceſſity of being formed, at different diſtances, to the very bottom of the declivity, which being afterwards in a great meaſure filled with looſe ſtones, merely conveyed away portions of ſurface water, without touching the ſpring, the great or principal cauſe of the wetneſs.

The effects of drains formed in this manner he aſſerts to be, that of rendering the ſurface of the land in ſome degree drier, ſo long as they continue to run with freedom; but as they are liable ſoon to be obſtructed and filled up, by ſand or

* See Johnſtone's Account of Draining Land, p. 23.

other materials, the water is often forced out in different places and directions, and thus renders the land equally wet, if not more ſo, than it was before.

In addition to this, it is likewiſe obſerved, in the work we have already quoted, that it is a more difficult taſk to drain the ground a ſecond time in a proper method, from the natural appearance of the ground being ſo much changed, and the burſts of the old drains, as well as the greater difficulty of aſcertaining the real ſituation of the ſprings.

It may ſometimes happen, however, as where the higheſt are the ſtrongeſt outlets, that they may be the main or leading ſprings; thoſe which ſhew themſelves lower down in the land being merely formed by the water of the main ſpring overflowing, and finding itſelf a paſſage from an opening, or the porous nature of the materials of the ſoil near to the ſurface, and from being obſtructed ſomewhat further down in the ground by ſome impervious ſtratum. This circumſtance muſt therefore, it is obſerved, be fully aſcertained before the lines for the ditches or drains are marked out.

In caſes where the bank or riſing ground is formed in an irregular manner, and from the erect nature of the ſituation or the force of the water underneath has been puſhed down, the ditches made for the purpoſe of draining ſuch lands ſhould, it is remarked, always be carried up to a much higher level in the ſide of the elevated ground than that in which the water or wetneſs appears, as to the firm unchanged land; by which means the water of the ſpring may be cut off, and the ground completely drained; which would not be the caſe if the trench or drain were formed on the line of the looſe materials lower down where the water oozes out, which is liable to miſlead the operator in forming the conducting trench, or that which is to convey the water from the croſs-drain on the level of the ſpring to the outlet or opening by which it is diſcharged. But where the main or principal ſpring comes out of a perpendicular or very ſteep bank, at a great height above the level of the outlet into which it may diſcharge itſelf by means of a drain, it will neither be neceſſary nor of any utility to form a deep trench, or make a covered drain, all the way from ſuch outlet up to it, as from the ſteepneſs of the deſcent the water would be liable, when the drain was thus cut, from the thin ſtrata of ſand, and other looſe materials, always found in ſuch caſes, to inſinuate itſelf under the bricks, ſtones, or other ſubſtances of which the drain was formed, to undermine and force them up by the ſtrength of the current, or, probably, in ſome inſtances, block the drain up by the looſe ſand, or other matters, which may be forced away and carried down by it; in ſituations of this kind, Mr. Johnſtone obſerves, it is always the beſt way

to begin juſt ſo far down the bank or declivity as, by cutting *in level*, the drain may be ſix or ſeven feet below the level of the ſpring, or ſuch a depth as may be requiſite to bring down the water to ſuch a level as will be ſuitable to convey it away without its riſing to the ſurface, and injuring the lands around it. The reſt of the drain, whether it be made in a ſtraight or oblique direction, need not be deep, and may, in many inſtances, be left quite open; it ſhould, however, be carefully ſecured from the treading of cattle, and, where the land is under an arable ſyſtem of cultivation, alſo from the plough. Where it is covered, the depth of about two feet may be ſufficient. There will not, in ſuch drains, be any neceſſity for the uſe of the auger in any part of them.

Where there is a difficulty in aſcertaining the line of the ſpring, and conſequently that of the croſs-drain, either from its not ſhewing itſelf on the ſurface, or from there not being any apparent outlet, it may, generally, be met with in carrying up the conducting drain for conveying away the water, which as ſoon as the operator diſcovers, he need not proceed any further, but form the croſs-drain, on the level thus diſcovered, to ſuch a diſtance on each ſide of the *tail*, or terminating part of the ſtrata, of whatever ſort, that contains the water, as the nature of the land, in regard to ſituation or other circumſtances, may demand. Where, in forming a croſs-drain, the line indicated by the ſpirit or other level is found to be in ſome places below that of the ſpring, and where, in boring in this direction, water is not found to follow, it will be neceſſary to make ſhort drains or cuts of the ſame depth with the croſs-drain from it quite up to the ſource of the ſpring; for if the drain be cut below the line of the ſpring, the poſſibility of reaching it by means of an auger is loſt, as where the under ſtratum is clay, and there is no under water, the uſe of the auger cannot be effectual; and if it be made above the line of the ſpring, it will be requiſite to cut and bore much deeper, in order to reach it, the ground being, in general, higher in that part; beſides the portion of porous ſtratum, below the drain, may contain a ſufficient quantity of water to render the land wet, and that may readily get down underneath the trench, between the holes formed by boring, and break out lower down. Theſe circumſtances are rendered more clear in the plan*.

In ſituations where the extent of bog in the valley between two banks or eminences is ſo narrow, and limited, as that the ſtratum of rock, ſand, or other materials that contains the water, may unite below the clay at ſuch a depth as to be readily reached by the auger, it will ſeldom be neceſſary to have

* See Johnſtone's Account of Draining Land, p. 27.

more than one trench up the middle, well perforated with holes by means of the auger; croſs or branching drains being unneceſſary in ſuch caſes. For notwithſtanding the ſprings, that render the land injurioufly wet in theſe caſes, burſt out of the banks or eminences on every ſide, for the moſt part nearly on the ſame level, the reſervoir from which they proceed may be diſcovered in the middle of the valley, by penetrating with the auger through the layer of clay, that confines and forces the water to riſe up and ooze out round the ſuperior edge of it, where it forms an union with the high porous ground. From the drain being made in the holloweſt part of the land, and the porous ſtratum containing the water being then bored into, it is obvious that the ditch or drain thus formed being ſo much lower than the ordinary outlet of the ſprings, the preſſure of water above that level, which is the bottom of the drain, muſt be ſuch as to force that which is under the drain or trench through the holes made by the auger, and in many inſtances, until a conſiderable quantity of the water is evacuated, make it riſe to a greater height than the level of its natural outlet. The effect of which muſt be, that the water forming the ſpring having found by theſe means a freſh and more eaſy paſſage, will quickly relinquiſh its former openings, and thus be prevented from running over and injuring the ground, that previouſly laid lower down than it *.—This will be better underſtood by the plate.

But in ſwamps or bogs that are extenſive and very wet, other drains or cuts than ſuch as convey off the ſprings muſt be made; as notwithſtanding the higher ſprings which chiefly cauſe the wetneſs may be intercepted, there may be lower veins of ſand, gravel, or other porous materials, from which the water muſt likewiſe be drawn off. In caſes of this nature where the land is to be divided into encloſures, the ditches may be formed in ſuch directions as to paſs through and carry off collections of water of this kind, as well as thoſe that may be retained in the hollows and depreſſions on the ſurface of the land †. It is alſo further remarked in the practical work juſt mentioned, that there are in many places very extenſive tracts of ground that are rendered wet, and become full of ruſhes and other coarſe plants, from cauſes of ſuch a nature as cannot be obviated, by the making of either open or covered drains, however numerous they may be. Lands in this ſituation are frequently termed holms, and moſtly lie on the ſides of ſuch rivers and brooks as, from the frequency of their changing and altering their courſes between their oppoſite banks, leave depoſitions of ſand, gravel, and other porous materials, by which land is formed, that readily admits

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 28. † Ibid. 29.

the water to filtrate and paſs through it to the level of the laſt-formed channels, and which preſerves it conſtantly in ſuch a ſtate of moiſture and wetneſs, as to render it productive of nothing but ruſhes and other aquatic plants; and if a pit or ditch be made in lands under theſe circumſtances, it quickly fills with water to the ſame level as that in the water-courſe. This effect is, however, more liable to be produced, as well as more complete, where the current of the water is ſlow, and its ſurface nearly equal with that of the land, than where its deſcent is rapid. Under ſuch circumſtances, while the river or brook remains at the ordinary height, no advantage can be gained, whatever number of drains be formed, or in whatever direction they may be made. The chief or only means of removing the wetneſs of land proceeding from this cauſe is, that of enlarging and ſinking the bed of the ſtream, where it can be effected at a reaſonable expence: where there is only one ſtream, and it is very winding, or ſerpentine in its courſe, much may however be effected by cutting through the different points of land, and rendering the courſe more ſtraight, and thereby leſs liable to obſtruct the paſſage of the water. But in caſes where there are more than one, that ſhould always be made the channel of conveyance for draining the neighbouring land, which is the loweſt in reſpect to ſituation, and the moſt open and ſtraight in its courſe. It may likewiſe, in particular inſtances, be advantageous to ſtop up and divert the waters of the others into ſuch main channels, as by ſuch means alone they may often be rendered deeper, and more free from obſtruction *: the materials removed from them may ſerve to embank and raiſe up the ſides to a greater height, as while the water can riſe higher than the outlets of the drains, and flow backwards into them, it muſt render the land as wet as it was before they were formed, and the expence of cutting them be thrown away.

In addition to the injury done by the water from the rivers in ſome ſituations, ſprings, it is obſerved, break out from the bottom of the more elevated banks, and are abſorbed ſo as to filtrate through the materials of the ſoil above their levels. The wetneſs proceeding from theſe, may be readily intercepted, or reduced to the level of the ſtream, by means of a drain. There are inſtances too, it is ſaid, in which the wetneſs ariſes entirely from ſprings; as where the ſoil of the flat land between them and the river is not formed of looſe ſand, or gravel, but of loam, or a mixture of clay and loam. In ſuch inſtances as theſe, the water proceeding from the ſprings is interrupted, and prevented from filtrating through the materials of the ſoil in its paſſage to the river, and thus forced up to the ſurface, over

* See Annals of Agriculture, vol. XXXVI. p. 88.

which it runs. In order to drain land in this ſituation, it is recommended that a trench ſhould be commenced at the lower end of it, and brought from the river on the bottom of the bank whence the ſpring breaks forth. It ought likewiſe to be cut *below* the line of the ſprings, where it can be accompliſhed with greater facility, and kept open, in order to take the river water in time of floods, which would blow or break it up if it were covered, and likewiſe ſuch runs of water from the more elevated grounds as may be produced by rains. Short covered drains muſt alſo be formed from this trench, a little diſtance into the bank, the bottoms of which ſhould be higher than the level of that of the open one, in order to prevent any of the water contained in it from running back into them. Where the depth of this level does not reach the ſtratum that contains the water, in ſuch caſes the auger may alſo be employed to tap or let off the water of the ſprings. Croſs-drains, between the open cut and the river, will not here be neceſſary, as the whole of the intercepted water will be conveyed along the bottom of the bank, and be diſcharged at a lower level into the river, except when the land is ſo extenſive as to admit of being divided by croſs-ditches into diſtinct incloſures. In theſe caſes the open drain, on the upper ſide, may ſerve as a diviſion between the meadow and the high grounds *.

After being drained, land of this deſcription is particularly well ſituated for watering, and the ſoil capable of being greatly improved by it, when proper modes are adopted.

Some attention is required, in the drainage of ſuch lands, to the method of forming the drains, and the neceſſity of their being open or covered. Where the land is to be incloſed at the ſame time that it is drained, as the line of the trench may, in moſt caſes, ſerve as a ſuitable diviſion of it, there can be no doubt but that an open drain will be the moſt proper; but where there is not a neceſſity for incloſing the land, a covered one may be preferable. Theſe points ſhould in the firſt place be determined upon, and the depth, width, and other circumſtances of the drain be regulated by them.

When the outlet, by which the water accumulated in the drain may be conveyed away, has been fixed upon, which ſhould generally be the neareſt and moſt convenient, a trench is directed to be brought up from it to the croſs-drain that is to be formed all along on the line of the ſpring; an inclination of a few inches in every eight or ten yards being given for the purpoſe of permitting the water to paſs away. When in cutting the drain that is to take off the ſpring,

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 30.

after getting through the clay, there happens to be a layer of firm gravel between it and the porous ſand or other material that contains the water, the drain ſhould be laid upon it, as being more ſolid; and to perforate the gravel with a punch, or dig ſmall pits in it by the ſpade, in order that the water may riſe up and paſs off with eaſe and ſafety, in preference to that of the ſand below; by laying it upon which, the depth and difficulty of conſtructing it would not only be greatly increaſed, but in different inſtances be incapable of being performed, from the level of the orifice not permitting its being cut to ſuch a depth. In cutting the drain or trench on the tail of a rock likewiſe, where ſuch kind of ſtratum exiſts, if the level of the orifice will not allow of its being made ſo deep as to reach the rock, the clay or other impervious ſtratum that may lie immediately above muſt be bored through, that the water may flow up through the fiſſures or cracks in the ſtone, and likewiſe the auger holes, into the drain or paſſage; but where the level will permit of it, it is obſerved, to be always more adviſable to cut the drain through the clay, and ſo far into the rock below as may be ſufficient for ſupplying the neceſſary quantity of ſtones for conſtructing the drain or ſough, as by means of the ſtone being thus broken, the water will have a more free and eaſy exit. The expence of cutting the drain may by this be ſomewhat increaſed; but probably, from its rendering the quarrying of ſtones in other places, and the carriage of them, unneceſſary, will, in moſt inſtances, more than compenſate ſuch additions of expence *.

Though, in the land to be drained, there may be an old ditch or water-courſe in which it may be poſſible to tap or let off the ſpring by means of the auger, it may, it is remarked, notwithſtanding, in moſt caſes, be preferable to make a new trench or drain, in which the water of the ſpring only may be conveyed; and in ſituations where it is under the neceſſity of croſſing ſuch old ditches or channels for water, it muſt be well ſecured by means of *puddling* with clay, ſo as not to admit any ſurface water, which, from its ſudden augmentation in caſe of floods, might quickly blow up, or break and deſtroy, the ſough or drain †.

As the water procured by tapping the ſprings in this way, may frequently be made to ſerve different uſeful purpoſes, ſuch as the irrigation of land, the turning of ſmall mills, the ſupplying of houſes, the filling of canals and ponds, in paſtures for the uſe of cattle, &c. the practice ſhould be adopted with great care, in order to guard againſt the loſs of water in one part of the drain by the ſame means that it may have been found in another, or by attempting to produce a

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 32. † Ibid.

larger ſupply. As by ſuch means it may, in many caſes, be let down from the wet retentive ſtratum on which it reſts into the dry porous one below, and thus be completely loſt.

When the drain is made through a ſoft boggy ſoil, and where it may have other water than that which riſes from below paſſing into it, it will, it is ſaid, be more proper to be open than cloſed, as the ſtones uſed in ſuch drains are, from the ſoftneſs of the foundation, ſoon found to give way and ſink down, and the ſough or drain liable to be filled up and deſtroyed. When the drain is covered, it is recommended to be made from three to four feet in width at the top, and from one and a half to two feet at the bottom, leaving in this way ſix or nine inches for each ſide ſtone, the ſame for the height, and ſix inches between for the conveyance of the water, conſtituting a ſquare paſſage or ſough *. The level of the ſituation where the drain is to diſcharge itſelf, and the nature of the land through which it is to be made, muſt regulate the depth. The turf is then to be pared off thin and laid on one ſide, in order to be made uſe of afterwards; and the whole of the mould that may be dug up, thrown out on the other. The moſt difficult part of the buſineſs conſiſts in laying the ſough when in running ſands †, it being frequently requiſite under ſuch circumſtances to have the ſides of the trench ſupported, and the looſe ſand prevented from falling down among the ſtones employed in conſtructing the drain, by means of flat boards and props, removed forwards as the work proceeds. When the ſough or paſſage is laid with brick, ſmall apertures ſhould be left betwixt each, to allow the water to paſs away from the ſides of the drain, and the thin turfs are then recommended to be placed over immediately upon the ſtones, without the intervention of any ſmall, looſe ſtones, the graſs ſide downwards to keep the mould from eſcaping through the crevices. This is neceſſary, as the water principally proceeds from the bottom of the drain, but very little from the ſides, and not the leaſt from the top ‡.

Turfs are alſo adviſed to be placed in the foundation of the drain underneath the trough in ſuch quick looſe ſands, to prevent them from flowing up, and to render the bricks more ſecure in caſe of their giving way. In ſands of this kind it is likewiſe a good way to dig juſt into the ſides of the trench, from the line of the ſough, where the auger is to be employed, and when this has been done to cover the places in the ſame way as the ſough; as by this means the ſand thrown up by the ſpring may be readily removed, till ſuch times as the

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 33. † Quick-ſands.

‡ Ibid.

force of the ſpring abates, and it is free from the main current paſſing in the middle of the drain.

The portion of ſough above the holes, made by the auger, is recommended to be left open, till ſuch times as the ſand is brought up, and the openings are become perfectly free; but until this happens the ſand ſhould be conſtantly removed. Afterwards the ſough may be covered up with the greateſt ſafety. An opening, or kind of funnel, is likewiſe adviſed to be conſtructed above ſome of the holes formed by the auger, or at ſome other convenient part of the drain, up to the ſurface, for the purpoſe of occaſionally inſpecting it and ſeeing that it is open and clear, and whether the run of water increaſes or is diminiſhed. When the holes made by boring are not ſufficient for diſcharging or letting off the full quantity of water that the ſpring can emit, and when the ſtratum containing the water is near to the bottom of the trench, and there is a bed of hard gravel between, which cannot be eaſily penetrated by the boring inſtrument, holes or openings are recommended to be dug down to the ſpring by the ſpade, and afterwards filled up with ſmall, looſe ſtones, a round ſtake or piece of wood being previouſly put down in the middle and withdrawn when the ſtones have been filled in, in order that a good opening for the water to flow up may be provided *. If no other water but what comes from the drain be admitted, there will, it is obſerved, be no danger in ſuch caſes of the holes formed by the boring inſtrument being filled up, whether it be in an open or covered ſtate, as ſuch is moſtly the force of the water iſſuing through them that it can eaſily remove thoſe portions of earth or mud that may have been accidentally waſhed into it; the drains can therefore, of courſe, only be damaged by the flowing in of much ſurface or flood water upon a ſudden †.

In reſpect to the materials employed for the conſtruction of drains of this kind, ſtones are certainly the beſt where they can be procured at a ſufficiently reaſonable rate. Bricks may likewiſe be made uſe of where ſtones cannot be had, of which there are ſeveral different kinds invented for the purpoſe, beſides thoſe of the ordinary ſort:—as may be ſeen in the plate. Where ſmall drains are only wanted, as in conducting water for domeſtic uſes, a brick excavated in ſuch a manner as to form a kind of ſmall arch, may probably be made uſe of with moſt advantage. But in caſes where larger drains become neceſſary, a more ſolid kind which are formed for the purpoſe in different ſhapes, may be employed with greater ſucceſs. A ſort has lately been formed in Warwickſhire, that has been much employed in the conſtruction of ſuch drains. In making uſe of bricks of this deſcription, they

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 35. † Ibid.

are laid ſingly, without having a reverſed one underneath; as when that is the caſe, it has been found, that the water paſſing on the under one, is apt to produce a ſort of earthy incruſtation, which in the coruſe of a few years becomes ſo great as, in ſome meaſure, to block up the paſſage of the water, and thus render the drain uſeleſs. Where the foundation is of a clayey nature, they may always be ſafely laid without having any thing underneath them; but where it is of a ſoft ſandy kind, a common brick may be placed under each ſide to retard their ſinking down, and ſo placed as to form a regular arch that may reſiſt the preſſure from above. They are capable of being conſtructed of the ſame ſhape to any ſize, according to the dimenſions of the drain, or the quantity of water it may convey *.

Though the earth that has been dug out of the drain in theſe caſes, when filled into it again, may at firſt appear conſiderably higher than the common ſurface of the land on the ſides, it ſhould be let remain in that ſtate, as in a little while it generally ſinks to the proper level; but when made exactly level at firſt, from the earth's gradually ſinking down, hollows are formed that afford lodgments for water, which by ſinking through may injure the drains.

In very wet peat grounds, during the time the drain is forming, the water from the ſurface, or that which may trickle from the ſides, before reaching the main body of water, ſhould be ſtopped occaſionally; and when let off into the ſough, a turf muſt be placed ſo as to prevent any ſoft earthy matter that may be forced down with it from paſſing through, as injury may be done by it. If ſuch trees as have ſpreading roots happen to be in the line of the drain, they ought to be completely grubbed up; as, if this be not done, the fibres of the roots, by extending themſelves through the joints and crevices of the ſtones, are apt to get into the drain, and quickly put a ſtop to the paſſage of the water in it †.

In caſes where the water iſſuing from drains is tinged of a red ochry colour, it is a ſign that there is a ſtagnation proceeding from ſome cauſe or other, as that which has been juſt mentioned, when the drain has been laid amongſt trees, or from the breaking in of ſome part of the ſough, which ſhould always be attended to, and removed or repaired as ſpeedily as poſſible, that the ground may not become again injured by wetneſs. In order to complete the buſineſs in all theſe caſes, the opening or mouth of the drain ſhould be carefully guarded by ſome means or other, ſuch as a railing, from being poached, or forced in, and choked up by the treading of cattle in their attempts to drink at it; and where injuries have occurred in this way, they ſhould always be ſpeedily removed. The circumſtances which firſt afford evidence of the efficacy of the drain, and which

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 37. † Ibid.

ſpeedily become obvious when the ſpring or reſervoir of water has been properly drawn off, are, that all ſuch ſurface drains as may have been formerly made, and the neighbouring pits, ditches, and other hollow places to which the water may have been dammed up, become ſuddenly dry, and afterwards continue in that ſtate*.

There are large tracts of boggy waſte land, in different diſtricts of the kingdom, that cannot be brought into a ſtate of cultivation, from a wetneſs which does not originate from ſprings immediately beneath the ſurface, or the overflowings of any in the neighbouring high grounds, but from the collected rain water becoming ſtagnant on a retentive body of clay, or ſome other impervious material, through which the water cannot ſink; and being likewiſe encircled with higher ground compoſed of the ſame impervious ſubſtances, the water of itſelf can have no outlet of the natural kind; when ſuch lands become ſoft and ſpongy, they frequently form bogs of a very confined kind. And as ſuch bogs are often ſituated very greatly below the ground that ſurrounds them, the opening of a main drain, or conductor, to convey off the water collected by ſmaller drains, would be attended, in many inſtances, with an expence greater than could be compenſated by the land after it had been drained. The thickneſs of the impervious ſtratum that retains and keeps up the water in ſuch caſes, is often ſo great, that though the ſtratum below be of a porous and open nature, ſuch as ſand, rock, or gravel, the water cannot of itſelf penetrate or find a paſſage from the one into the other, conſequently, by its continued ſtagnation above, all the different coarſe vegetable productions that have for a great length of time been produced on its ſurface, and probably the upper part of the ſoil itſelf, are formed into a maſs or body of peat earth, equally ſoft and leſs productive than that of any bog originating from water confined below, and which is only capable of ſuſtaining the weight of cattle in very dry ſeaſons, when the wind and ſun have exhaled and dried up a great part of its ſurface moiſture, but even then it is incapable of admitting the plough upon it †.

As the cauſe of theſe kinds of bogs is materially different from that of thoſe which have been already noticed, their drainage muſt of courſe be accompliſhed in a different way. The following method of proceeding is recommended as perhaps the leaſt expenſive. In the middle, or moſt depending part, of the ground, the firſt drain may be cut, into which all the others ſhould be made to lead: the number and direction of which muſt be regulated by the extent of the bog. They ſhould be cut through the peat, or moiſt ſpongy upper ſoil, to the

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 38. † Ibid. p. 51.

ſurface of the clay, or other retentive ſtratum of materials, which muſt then be perforated or bored through in order to let the water down into the pervious ſtratum below, by which it may be abſorbed and taken up. The ſame effect might be produced by forming one large well, or pit, in the middle or loweſt part of the bog, by digging through into the porous ſtratum below, and connecting the other drains with it, as by ſuch a method the trouble and expence of boring along the drains would be ſaved.

In theſe caſes, when drains are made, they ſhould always be cut as narrow as it is poſſible to make them, and after the holes have been formed in them by boring, filled up with looſe ſtones to within about a foot and a half of the ſurface, which ſpace may be made up by a portion of the earth that had been taken out, putting a turf the green ſide to the ſtones before the earth is thrown in. By this means the water and prejudicial moiſture of the peat, or upper ſoil, may be taken away by the drains, and paſs off through the holes that have been formed in their bottoms. But where pits are employed, theſe ſhould only be filled with ſmall ſtones to the level of the bottom of the drain, the filling being performed as ſoon as poſſible after they are formed *: where there is a chalky ſtratum below, after taking it out, the flints contained in it may be made uſe of in this way, with much advantage; and where the drains can be carried into quarries, where the ſtone is much fiſſured, nothing more will be neceſſary †. Where land of this ſort is afterwards to be ploughed, great attention ſhould be given to the forming of the ridges, and giving them a regular deſcent towards the main drain, which will contribute greatly to the aſſiſtance of the others, in conveying off heavy falls of rain water when they occur.

But previous to any attempt to drain lands of this kind in the way that has been deſcribed, it is recommended as proper to aſcertain whether the porous ſtratum under the clay be dry, and capable of receiving the water when let down into it; or already ſo loaded with moiſture itſelf, as, inſtead of receiving more from above, it may force up a large quantity to the ſurface, and thus increaſe the evil it was intended to remove. This may be the caſe in many inſtances; and the ſubſtratum contain water which affords no appearances of wetneſs on the ſurface, at the place, on account of the compact body of clay that is placed over it, but which, from its being connected with ſome ſpring that is higher, may flow up, when an opening or paſſage is given it either by means of a pit or the auger. In this way a

* See Anderſon's Treatiſe on Draining, p. 88. † See Hertfordſhire Agricultural Report.

greater quantity of water might be brought to the ſurfaces, which, from its being confined by the ſurrounding banks, would render the ground much more wet than before, and in particular ſituations produce very great degrees of wetneſs. When the ſurrounding high ground declines lower than the bog, though it may be at a conſiderable diſtance, by the aid of the level, and the appearance of the ſurface, the nature of the ſtratum underneath may, it is obſerved, in ſome degree, be aſcertained; and, notwithſtanding it may already contain water, a drain may be formed into it to carry off that water, and what may likewiſe be let down into it from the retentive ſtratum that lies above it;—as is ſeen by the plate.

Methods of draining hilly lands.—The draining of hills, and elevated paſture lands, have hitherto been but little attended to, though the herbage which is produced by the wetneſs of them from ſuch inattention is, probably, the principal cauſe of a diſeaſe extremely fatal to ſome of the animals which they ſupport.

Draining, in ſituations of this kind, is not, in general, attended with great expence, as the drains need ſeldom be covered or filled up, only in ſuch places as may be ſufficient for paſſages for the animals to croſs by. And though, where the depth of the trench does not come to the water confined below, it may be neceſſary to perforate lower, there need not be any fear that the holes will fill up, even where the drain is left open, as the impetuoſity of the water itſelf, as has been ſeen, will remove any ſand or mud that may fall into them, where much flood or ſurface water does not get in: ſmall openings may, however, be made along the upper ſide of the trench, in order the more effectually to ſecure them againſt any obſtructions; and in theſe the perforations may be made, leaving the mouth of the holes about ſix inches higher than the bottom of the drain, which will be without the reach of the water that may be collected during the time of heavy rains. This may, however, be better underſtood by the repreſentation in the plate *.

The ſides or declivities of many hills, from the irregularity of the diſpoſition of the ſtrata that compoſe them, are often covered with alternate portions or patches of wet and dry ground. By the general appearance of the ſurface, and the vegetable products that are grown upon it, the nature and direction of the internal ſtrata may, as has been already obſerved, frequently be aſcertained with ſo much certainty, as to determine the line or direction of a drain, without the neceſſity of examining below the ſurface of the land, as the eaſe or difficulty of draining ſuch grounds depends ſolely on the poſition of the different ſtrata of which the hill or elevation may be formed, and upon the erect or ſlanting direc-

* See Johnſtone's Account of Elkington's Mode of Draining Land.

tion of the rock, or other retentive body in which the water is contained; where the rock has a ſlanting or horizontal inclination, the whole of the different ſprings or outlets, that ſhew themſelves on the ſurface, may originate from or be connected with the ſame collection or body of water, and may be all drained and dried up by cutting off, or letting out, the main body of water, by which they are ſupplied, at the inferior part of the reſervoir, or that part where the water would of its own accord readily run off, if it were not confined beneath an impervious covering of clay, or ſome other material.

But in caſes where the rock lies in an erect or perpendicular form, and contains only partial collections of water, in ſome of the more open cracks or fiſſures of the ſtone, that diſcharge themſelves at various openings, or outlets, that have not the leaſt connection with each other; it would be an idle and fruitleſs endeavour to attempt the cutting of them off, by means of one drain, or by boring into any one of them in particular, without cutting a drain into each, as is ſhewn in the plate. In this caſe it is more adviſable to make the main drain wholly in the clay, with ſmall cuts made up to each outlet, than along the place where the ſprings burſt out; as in that line or direction it would be too greatly in the rock, and conſequently be extremely difficult to cut, on account of the nature and diſpoſition of the ſtone: when the water paſſing out on the line of the ſprings can be found by the auger in the main drain, at the point where it joins it, it will, it is obſerved, be the more completely cut off; but where this is not practicable, the depth of the ſmall cuts may reduce it to ſuch a level as will prevent its flowing over, and injuring the ſurface of the land below it *.

In ſuch hills as are conſtituted of alternate ſtrata of rock, ſand, and clay, the ſurface of the latter may frequently be wet and ſwampy, while that of the former is dry, and capable of producing good crops of graſs; in all ſuch caſes, in order to drain the land completely, as many cuts will be neceſſary as there may happen diviſions of wet and dry ſoil: the ſummit, or moſt elevated part of ſuch hills, being moſtly formed of looſe porous materials, through which the rain and other water deſcends, till its paſſage becomes obſtructed by ſome impervious bed or ſtratum, ſuch as clay, when it is forced up to the ſurface, and runs or oozes over the obſtructing ſtratum; and after having overflowed, the upper clay ſurface is immediately abſorbed and taken up by the ſucceeding porous one, and ſinking into it in the ſame way as before paſſes out again at the lower ſide of it, and renders the ſurface of the next clayey bed prejudicially wet as it

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 45.

had done in the firſt. In this way the ſame ſpring may affect all the other ſtrata of the ſame kind, of which the hill conſiſts, from the higheſt part down the whole of the declivity, and produce in the baſon, or hollow at the bottom, a lake or bog, ſhould there not happen to be a paſſage or opening to take away the water. In order effectually to drain hills of this kind, it is remarked, that it will be the moſt adviſable to begin by forming a trench along the upper ſide of the uppermoſt ruſhy ſoil, by which means the higheſt ſpring may be cut off; but as the rain and other water that may come upon the next portion of porous ſoil may ſink down through it, to the loweſt part, and produce another ſpring, a ſecond cut muſt be made in that part to prevent the water from affecting the ſurface of the ſucceeding clayey bed. And ſimilar cuts muſt be formed ſo far down the declivity as the ſame ſprings continue in the ſame way to injure the land, and in ſome caſes a ſufficiency of water may probably be obtained to irrigate the land below, or for ſome other uſeful purpoſe.

It ſometimes happens, however, that the ſtrata of which hills are compoſed are diſpoſed with ſuch regularity, as has been already ſhewn, that the water contained in them may be capable of being taken away from either ſide on the ſame level, a circumſtance which might be in ſome caſes advantageouſly applied in draining one ſide, and watering the other, as there is frequently on one ſide wet ſwampy ground, while on the other it is much too dry for the purpoſes of healthy vegetation. This often ariſes from the retentive body of clay that keeps up the water not being diſpoſed in a horizontal or ſlanting direction, but having a dip or depreſſion more to one ſide than the other, and from the dry ſide being overlapped by a ſtratum, or covering of clay, on which account the water is under the neceſſity of iſſuing at the open ſide; but when a paſſage is afforded it on the dry ſide, by a drain or trench lower than that by which it paſſes off on the wet ſide, the courſe of the water below may be changed without much difficulty *. From the oppoſite ſide being porous and ſandy, it becomes a reſervoir for the reception of the rain water, which afterwards diſcharges itſelf through the opening formed in the clay; a circumſtance which may be of much utility in furniſhing water for domeſtic uſes, in caſes where the ſituation, in reſpect to the hill, will admit of it, and thus render the additional expence of conveying it by other means unneceſſary. Where a reſervoir of water is confined in a low ſituation contiguous to higher land, it may often be raiſed ſo as to ſupply houſes, or be otherwiſe uſeful, notwithſtanding it is much below that level, by confining

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 47.

it in a pipe or narrow brick opening. For the reſervoir or collection of water whence the ſpring or outlet of water is furniſhed being pent up, and confined between two impervious ſtrata, and the higher part of it extending probably in many caſes to a great height and diſtance in the elevated ground, it is plain that if a hole, or perforation, be made through the ſuperincumbant ſtratum, into the loweſt part of the porous bed containing the water, it may be raiſed by being confined nearly as high as the level of the head of the reſervoir, or collection of water. In conducting drains for ſuch purpoſes as theſe it will, however, always be neceſſary to be cautious not to cut or bore in them ſo deep as to reach a porous ſtratum, as by that means the water that had been found in one ſituation might be thus let down and loſt in another *. Theſe different caſes of draining may be better underſtood by the plate.

The poſſibility of raiſing water in particular ſituations by different methods of this nature, has been fully ſhewn in various inſtances, in digging wells and pits to great depths.

Methods of draining mixed ſoils.—Where the ſoil is of a mixed and varied nature, but the moſt prevailing parts of the clayey kind, the buſineſs of draining is conſiderably more tedious and difficult, than where the ſuperficial and internal parts have greater regularity. In ſuch ſorts of lands, as all the different collections of water are perfectly diſtinct from each other, by means of the beds of clay that ſeparate them, each collection becomes ſo much increaſed, or accumulated, in the time of heavy rains, that they are filled quite to the level of the ſurface of the clay, by which they are ſurrounded, when the water getting a free paſſage, as it would over the edges of a bowl or diſh, overflows and ſaturates the ſurface of that bed of clay, in ſuch a manner as to render it ſo perfectly wet and ſour, that its produce becomes not only annually more and more ſcanty, but the ſoil itſelf more ſterile and unproductive.

From the ſand beds in ſuch caſes having no communication with each other, it muſt evidently require as many drains as there are beds of this kind, in order fully to draw off the water from each of them. A drain or trench is therefore recommended to be cut from the neareſt and loweſt part of the field intended to be drained, up to the higheſt and moſt diſtant ſand bank, in ſuch a line of direction as, if poſſible, to paſs through ſome of the intermediate ſand beds, and prevent the labour and expence of making longer cuts on the ſides, which would otherwiſe be requiſite; but where many awkward turnings in the main trench would be the conſequence of this, and would lengthen it, and where, by

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 48.

paſſing acroſs the beds in parts higher than the ſurface of the clay which ſurrounds them, it would greatly increaſe its depth, and be worked with difficulty, eſpecially when rock or running ſand, drains, made ſomewhat in the ſhape of a Y, ſhould branch off to the different beds, in order to take off the water they may contain, and convey it into the principal one, as ſhewn in the plate*.

But notwithſtanding the ſand beds let the water they contain out on every ſide, in ſuch a way as to injure the clay ſurface quite round them, it is further obſerved, that a drain made on one ſide, may be ſufficient to completely draw off the water from the whole, and hinder it from burſting out at either ſide, if the place where it is cut be the loweſt, or moſt depending. But unleſs the drain be ſo cut, it cannot poſſibly have this effect, while the water can meet with a paſſage on the contrary ſide of the bank, lower than the bottom of the drain. This circumſtance muſt, therefore, in the firſt place be attended to; and by a careful examination of the ground, and the application of the level, the moſt proper ſide and ſituation for the drain may be readily aſcertained. And when the water breaking out round the bank has been ſeen in dry ſeaſons to run at one part, and not at the others, it is a ſign that that is the loweſt point, and that by cutting the drain on the line of that level, the water may afterwards be prevented from riſing ſo high as the upper outlets, or above the level of the bottom of the drain, even in the moſt wet times of the year †.

But, beſides the lands conſtituted in this way, there are others that have much ſimilarity, only the different beds are of leſs extent, and lie together with greater regularity, in conſequence of which they can be drained in a more eaſy manner with leſs cutting, and of courſe at leſs expence. Below the layers or beds of ſand and clay that lie, in this manner, alternately together, and nearly parallel to each other, is, generally, it is remarked, a body of impervious clay, which keeps up the water that is contained in the ſand, and which being conſtantly full, renders the adjacent clay moiſt, and in wet ſeaſons runs or trickles over it. As in theſe caſes the principal under ſtratum of clay is rarely above four or five feet below the ſurface, a drain is adviſed to be cut to that depth through the middle of the field, if it have a deſcent from both ſides; but if it declines all to one ſide, the drain muſt be made in that place, as the water will more readily diſcharge itſelf into it; and, unleſs the field be of great extent, and have more depreſſions or hollows in it than one, one drain may be quite ſufficient for the pur-

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 65. † Ibid, 66.

poſe, as by croſſing the different beds that retain the water it muſt take it off from each of them;—as may be ſeen in the plate *.

A principal difficulty in draining ground of this nature, and which renders it impracticable by one drain, is when the direction of the alternate layers, or beds of clay and ſand, lie acroſs the declivity of the land, ſo that one drain can be of no other ſervice than that of conveying away the water after it has paſſed over the different ſtrata, and would naturally ſtagnate in the loweſt part of the field, if there was no other paſſage for it. Where the land lies in this way, which is frequently the caſe, it will therefore, it is remarked, be neceſſary, beſides the drain, in the loweſt part, to have others cut up from it in a ſlanting direction, acroſs the declivity, which, by croſſing all the different veins, or narrow ſtrata of ſand, may be capable of drawing the water from each of them;—as ſhewn in the plate †.

We have already explained the method to be purſued in draining, where ſuch alternate ſtrata are more extenſive, and the wetneſs produced by larger ſprings, ſo as to form ſwamps, at very different heights or levels, on the ſides of ſuch hills, or elevated grounds.

In the draining of mixed ſoils of this kind, it will always be firſt neceſſary to aſcertain, with accuracy, the inclination of the alternating ſtrata, or the poſition of them, in reſpect to the field to be drained, as this muſt in a great meaſure guide the direction of the drains. This may be effected in moſt caſes from the appearances of the ſurface of the ground, the nature of the herbage, and other circumſtances, as has been already ſhewn.

In drains under theſe circumſtances there is rarely any neceſſity for perforating the bed below, as the required depth of the trench is fully ſufficient, and as there is either no reſervoir of water, which from the want of connection with higher land can riſe up through the perforations, or it is at ſuch a depth, and under ſuch a body of clay, that it cannot be injurious to the ſurface ground ‡.

In theſe caſes it is recommended that the drains, after being formed at the bottom, in the manner of a ſough, or ſet in the way of a triangle, be filled ſome way up by ſmall ſtones, tough ſods being applied green ſide downwards upon them before the mold is filled in. But where ſtones cannot be readily procured, faggots may be employed in their place, where they are plentiful: the under part of the drain being laid, or coupled with ſtones, ſo as to form a channel or paſſage for the conveyance of the water that may ſink through the faggots,

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 67. † Ibid, p. 68. ‡ Ibid. 69.

and for the purpoſe of rendering them more durable; as where the water cannot get freely off, which is generally the caſe where there is not an open paſſage made of ſome ſolid material, it muſt, by its ſtagnation, ſoon deſtroy the faggots, and choke up the drain *.

In fully accompliſhing the drainage of ſuch kinds of ſoils as theſe, attention ſhould always be paid, where the land is much on the deſcent, to mark out the branching drains in a ſufficiently horizontal direction, ſo that the fall may not be too rapid, by which the bottom of the trench may be rendered uneven, and the paſſage of the water be thus impeded, which might ſoon force them up and make them uſeleſs; but the fall ſhould, however, be ſo much as that the water may fully clear its way. The circumſtance that renders fewer drains neceſſary in ſuch lands as have a horizontal poſition, is, that the water is brought equally from the ſides of them, while thoſe on a ſloping direction only draw from the upper ſide of the drains, conſequently require them to be more numerous and cloſer to each other. Indeed, in all ſituations where ſurface draining is to be had recourſe to, this is the caſe; but it is more particularly ſo in ſuch ſorts of grounds as have a retentive ſubſtratum, on which the porous ſurface materials are depoſited.

Soils conſtituted of beds of clay and ſand, in the manner that has been juſt deſcribed, are ſometimes characteriſed and known in places where they are very prevalent, as ſome parts of Lancaſhire, by ſuch terms as have a relation to the circumſtance of their holding water, in the way that ſome kinds of veſſels do †.

Sometimes, too, the water is found to be retained in ſmall beds of ſolid rock, that are croſſed and intercepted by beds of clay ‡.

Methods of draining retentive ſoils.—The practical mode of drainage in ſuch ſoils as are compoſed of porous materials above, and ſuch as are retentive below, or the contrary, is materially different from that which has been deſcribed above. Many tracts of level land are injured by the ſtagnation of a ſuperabundant quantity of water in the upper parts of the ſurface materials, which does not riſe up into them, from any reſervoirs or ſprings below. The removal of the wetneſs in theſe caſes may, for the moſt part, be effected without any very heavy expence. From the upper or ſurface ſoil in ſuch caſes being conſtituted of a looſe porous ſtratum of materials, to the depth of from two to four or five feet, which has a ſtiff retentive body of clay underneath it, any water that may come upon the ſurface from heavy rains, or other cauſes, readily filtrates and ſinks down through

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 69. † *Sand-pots*, or *gut*. ‡ Ibid 70.

it, until it reaches the obſtructing body of clay, which prevents it from proceeding; the conſequence of which is, that the porous open ſoil above is ſo filled and ſaturated with water, as to be of little utility for the purpoſe of producing crops of either grain or graſs. Land ſituated in this way is frequently ſaid to be wet bottomed by farmers: in order to remove this kind of wetneſs, it ſeldom requires more than a few drains, made according to the ſituation and extent of the field, of ſuch a depth as to paſs a few inches into the clay, between which and the under ſurface of the porous earth above, there will obviouſly be the greateſt ſtagnation, and conſequently collection of water, eſpecially where it does not become much viſible on the ſurface. In theſe caſes there is not any neceſſity for having recourſe to the uſe of the boring inſtrument, as there is no water to be diſcharged from below.

When the field to be drained has only a ſlight declination, or ſlope, from the ſides towards the middle, one drain cut through the porous ſuperficial materials into the clay, in the loweſt part of the ground, may be ſufficient to bring off the whole of the water detained in the porous ſoil. This effect may likewiſe be greatly promoted by laying out and forming the ridges ſo as to accord with the direction of the land, and by the uſe of the plough or ſpade in removing obſtructions, and deepening the furrows, but which may be better underſtood by the plate*. In ſuch ſituations, where the drain has been formed in this manner, the water will flow into it through the porous ſurface materials, it is obſerved, as well as if a number of ſmall trenches were cut from it to each ſide, as is the practice in Eſſex, and ſome other parts of the country; but which is evidently an uſeleſs and unneceſſary labour and expence, and beſides the field is greatly injured by ſo much cutting. The drain made in the hollow may frequently ſerve as a diviſion of the field, in which caſe it may open; but in other circumſtances it may be more proper to have it covered †.

Where a field of this deſcription has more than one hollow in its ſurface, it is remarked, that it will obviouſly be requiſite to have more than one main drain; but when it is nearly level, or only inclines ſlightly to one ſide, a trench or drain along the loweſt part, and the ridges and furrows formed accordingly, may be ſufficient for effecting its drainage:—as may be ſeen in the plate. There may, however, be caſes, as where a field is large and very flat, in which ſome ſide cuts from the principal drain may be neceſſary, which muſt be made a little into

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 71.

† Ibid, p. 72.

the clay, and as narrow as they can be wrought, and then filled up with ſtones or other ſuitable materials, in the manner that will be preſently deſcribed. Theſe points may be better underſtood by the plate.

But though this is the plan that is to be purſued in draining ſoils where the porous body is upon the ſurface, there are other more extenſive caſes of ground which are alſo much injured from wetneſs, but in which the ſoil is formed in a directly oppoſite manner, the clay ſubſtance conſtituting the ſurface, and the porous body being underneath. We have already pointed out the methods of proceeding in caſes of this kind, where the wetneſs of the land is ſuch as to do great injury, and where the retentive bed or ſtratum that keeps up the water is of ſuch a depth as to be under the neceſſity of being perforated, or bored through by means of inſtruments. But, from the depth of the drain itſelf being in theſe caſes ſufficient to penetrate to the porous ſtratum below, the mode of draining them is to be noticed in this place.

In general, lands of this nature lie extremely flat, and without the leaſt declivity, by which the injurious ſtagnant water on the clay ſurface can poſſibly get off, without the aſſiſtance of drains being formed for the purpoſe; but in ſoils of the ſame ſort where the ſituation is more of a declivity, there is rarely any bad effects from the ſame cauſe. Soils of this nature are however drained with greater difficulty, and require a much greater number of trenches or cuts, than thoſe of any other kind, as they muſt be marked out and diſpoſed in ſuch a way as to collect and convey the water every-where from the ſurface; as it can only force itſelf off into them from above, being prevented from ſinking in through the clay, as in thoſe ſoils of a contrary kind. Where there happens to be hollows or irregularities in the ſurface of the land, water may often be obſerved to continue ſtanding in them, at the diſtance of but a few feet from the drain. In draining ſuch lands, it will, it is obſerved, always be neceſſary, in the firſt place, to make a large or conducting drain at the loweſt part, or the end of the field, for the purpoſe of receiving and conveying away the water collected by the leſs collateral cuts, which it may be neceſſary to make on each ſide of it. Where it ſuits for the purpoſe of dividing the land, this principal drain may be better to remain open than be covered, as by that means the mouths or outlets of the different ſmall drains that come into it may be conveniently examined, and cleared out when neceſſary *.

In ſuch ſoils too, when they are under tillage, the conſtruction of the ridges,

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 74.

ſo as that they may accord with the declivity, is a matter that muſt be carefully kept in view. They ſhould in all ſuch caſes have alſo that degree of elevation or roundneſs in the middle that may be ſufficient to afford the water ready fall into the furrows, which ſhould likewiſe have ſuch a depth and fall as may take it quickly into the drains. The ridges, beſides being well laid up, ſhould have ſmall open drains formed in a ſlanting direction acroſs them, in ſuch a manner as to form communications with one another, and with the furrows; by which means they are made to perform the office of drains, the water coming upon the ridges being thus readily conveyed into the furrows, where it proceeds till impeded in its courſe by the riſing of the ground or other cauſes, it then paſſes through the open croſs-drains into others, where the deſcent is greater, and is ultimately conveyed off into the ditch, or other paſſage, at the bottom of the inclosure. The elevation of the ridges ſhould probably too be made greater for the winter than the ſummer crops, as there muſt be much more injurious moiſture at the former than the latter ſeaſon. This may be eaſily accompliſhed at the time of ploughing the land.

By theſe means, therefore, a large portion of the rain water might be conveyed off as it falls, and the number of ſmall cuts that would otherwiſe be required, be much diminiſhed. The drains, when neceſſary, ſhould alſo be cut as narrow as poſſible, and be filled up with ſmall ſtones in the way that has been noticed; and the bottom or ſough of the principal or conducting drain, where it is not an open one, ſhould be formed with a ſmall channel or conduit at the bottom, in the way that has been mentioned, in order to facilitate the paſſage of the water. It is the beſt method too to form the ſmall drains by what is termed *coupling*: that is, placing the ſtones in the bottom, in an inclining direction on one another, ſo as to form a ſort of triangular opening of from four to ſix inches underneath. From the water being wholly brought in from the top of the drains, it is requiſite that they be filled with ſmall ſtones up to ſuch a diſtance from the ſurface, as will juſt admit the plough or harrow to paſs over without diſturbing them, which ſpace ſhould be covered in with looſe gravel. Where ſuch gravel can readily be procured it is always to be preferred, to the tenacious clayey earth that came out of the trench, from its more readily admitting the water to filtrate and paſs through it into the ſtones. A thin coat or layer of ſtraw or ruſhes, or what is ſtill better, where the land is in a ſtate of paſture, the ſurface turf pared thinly off, muſt be applied over the ſtones, in order to guard againſt the ſmaller parts of the gravel from inſinuating themſelves, and filling up the openings be-

tween them. This is not, however, ſo neceſſary to be done when gravel is uſed, as when mold is the material made uſe of *.

This method of removing water from land is, it is obſerved, ſuited to every tenacious clay ſoil, whether it be porous or not below; but in many caſes deepening the furrows with very few drains might prove ſufficient for remedying the injury, where the retentive upper ſoil is only of the depth of a foot or two, with an open or porous material beneath it, through which the water could readily ſink downwards, and be diſcharged again at ſome lower part of the field. The drains and furrows ought conſequently to be deepened quite through the clay into the porous ſoil, in order to fully expedite the deſcent and diſcharge of the water. Hence it is obvious, that a great deal depends on the judicious ploughing of ſuch land, as by it the labour of cutting might be much abridged, or perhaps nearly prevented.

Much may likewiſe be effected in many caſes of clayey ſoils, both of the deep and thin kinds, by breaking and opening them well up, to ſuch depths as may allow the water to ſink down to ſuch a diſtance as will render it not prejudicial to the crops that may be cultivated upon them; and by the incorporating of dung and calcareous manures with them in large proportions, as may be ſeen by the effects of deep trenching in the buſineſs of gardening. This ſhould be performed by ſuch implements as operate deeply, without turning the mellow ſurface mold down underneath †.

When hollow drains are neceſſary, in digging of them there is conſiderable art, as they ſhould be formed with as much truth and exactneſs as poſſible, which can only be done by ſuch perſons as are converſant with the nature of the buſineſs. Such labourers as are not dexterous in uſing their tools ſeldom make them well. The moſt general method of performing this ſort of work is by admeaſurement, at ſo much a rod, or a ſcore rods, which neceſſarily induces the workmen to do as much as they poſſibly can; they ſhould therefore be frequently inſpected, to ſee that they keep to the proper and required depth, and that the earth taken out be laid in ſuch a manner, as not to fall down again into the drains in time of filling them, and that the ſurface mold be kept on one ſide free from the clayey or other material of the inferior ſtratum ‡.

Thoſe who have been in the habit of draining land, now in general begin to

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 74.

† See Anderſon's Practical Treatiſe on Drainings, p. 99. ‡ Ibid. p. 149.

ſee the great advantages of making their drains, in theſe caſes, when there is any declivity in the ground, in a ſlanting direction acroſs it, inſtead of the old method of conducting them according to the nature or inclination of the ſlope. By attending to the former mode of cutting the drains, the wetneſs is not only more effectually removed, but, by allowing the water to paſs away in an eaſy current, they are rendered leſs liable to be choked, or as it is frequently termed blown up, by which artificial oozings of water are ſometimes formed in ſuch places. But where grounds are either quite or nearly level, as is the caſe in many of the weſtern diſtricts, it has long been a general practice, and where the wetneſs to be removed ariſes entirely from ſurface water, by no means to be diſregarded, to cut the drains at the different diſtances of about ſixteen, twenty-four, and thirty-two feet from each other, acroſs the fields from the different ditches, according to the circumſtances of the lands; or, indeed, where the drains, either from ſome ſlight unevenneſs of the ſurface, or other cauſes, can only be made to flow at one end, to avoid cutting them further on one ſide, than where the ditch is capable of taking away the wetneſs. In caſes where the declivities of a piece of ground are various, and have different inclinations, the drainer ſhould conſtantly attend to them, and direct the lines of his drains in ſuch a manner, as that they may croſs the higher ſides of the different declivities in a ſlanting direction.

The depth of all ſuch drains muſt depend upon the nature of the ſoils, the poſitions of the land, and a great variety of other more trifling circumſtances. It was formerly the cuſtom to make them three or four feet in depth, but by modern drainers they are rarely made to exceed thirty, or perhaps a few inches more, the moſt general depth being from twenty-four to twenty-ſix inches. As the main drains have more water to convey away, and are generally of greater length, than the lateral ones, they ſhould always be cut ſomewhat deeper; and where the materials of the ſoils are porous, the greater depth they are cut, the more extenſively they act in lowering the wetneſs of the land, to ſuch a degree, as that it can be little injurious to the crops, whether of grain or graſs, that may be produced upon it: when, however, the operator reaches any impervious material in the ſoil, through which the moiſture cannot paſs, it will be quite uſeleſs to dig the trench to a greater depth. If it be clay, by going a few inches into it, a more ſafe paſſage for the moiſture may however be ſecured. It muſt notwithſtanding be invariably attended to, that the depth be ſuch as that the treading of heavy cattle may not diſplace, or in any way injure, the materials employed in conſtructing or filling them. It may be noticed too, that where the

horſes in ploughing tread in the bottom of the furrow, at the depth of four or more inches below the ſurface, that, if eight or ten more be allowed for the materials with which they are filled, when the depth of the trenches are not more than twenty-four inches, there will only be nine or ten inches of earth for the ſupport of the horſes in the exertions of ploughing. Where the earth has been ſtirred, ſuch a depth muſt undoubtedly be too little, and in ſome meaſure proves that drains of ſuch a depth are not ſufficient. By cutting them down to the depth of two feet and a half in the ſtiffer ſoils, they will ſeldom be penetrated to, or have too great a depth; and in the pervious ones a ſtill greater depth is highly uſeful, and conſtantly to be practiſed *.

The practice of cutting the drains as narrow as poſſible, which has lately been much attended to in moſt of the eaſtern diſtricts, is of much importance, as it cauſes a conſiderable ſaving of the matters employed in filling them up, whether they be wood or ſtraw; but in caſes where bricks or ſtones are employed, this cannot be ſo much attended to; however, there is ſeldom, Mr. Johnſtone obſerves, a neceſſity for a greater width than about a foot, provided the ſtones be *coupled* at the bottom, or thrown in in a mixed way, nor more than ſixteen inches where laid in the manner of a ſough or channel. But of whatever depth the materials may be, the earth or mold by which they are covered up ſhould not be leſs in depth than a foot, in arable lands it ſhould indeed be more. The dimenſions repreſented in the plate are proper for ſuch lands as are wet from ſurface water, or the ſtagnation of it in the upper ſoil.

In lands in the ſtate of paſture, eſpecially where the ſoils are ſtiff and tenacious, gravel, when it can be procured, is always to be preferred for filling with, and the earth thrown out may ſerve for filling hollows in the fields.

It is an advantageous practice in ſome caſes, as where the land to be drained is in ſuch a ſtate as to admit of it, to make uſe of the plough in opening the upper parts of the drains. The method of performing the buſineſs as deſcribed by a celebrated drainer is this: when the drains are ſet out in the field, which is commonly done at the diſtance of about a rod from each other, two furrows are drawn with a foot-plough, a *baulk* of about fifteen inches in width being left between them, which baulk is then ſplit, by means of a ſtrong double breaſt-plough conſtructed for the purpoſe, and a clean furrow fourteen or fifteen inches in depth left. In ſome caſes, where the ſoil is ſo deep as to require it, as it is advantageous to touch the ſurface of the clay, by a ſecond uſe of the plough, the furrow is ſunk to the depth of eighteen or twenty inches; it is then in a ſtate of

* See Johnſtone on Draining, p. 147.

preparation for the land-ditching ſpade, by the uſe of which the drain may be dug to the depth of fifteen inches more, as narrow as it is capable of being made*.

When ploughs for the purpoſe cannot be readily procured, the buſineſs may be performed by means of a common plough, and a ſtrong team, ſo as to ſtir the ground to the depth of five or more inches, making a double furrow by throwing the earth on each ſide, and letting a baulk remain in the middle. This baulk is, Mr. Johnſtone ſays, to be raiſed in a ſimilar manner, by a ſecond bout of the plough, and then as much depth as poſſible is to be got by going twice in the open furrow with an ordinary double breaſt-plough. The looſe mold and irregularities are next ſhoveled out to the breadth of a foot, by which a clear open furrow is produced of different depths, according to the nature of the ſoil and the ploughs employed, but moſtly about eight or nine inches. One ſpit is afterwards dug out to the depth of fifteen or ſixteen inches, with the draining ſpade, producing ultimately a depth of two feet or more. Where this depth is not ſufficient, which is often the caſe, one or two ſpits more are thrown out, by which a depth of three or more feet is frequently formed.

As where a large quantity of water is made to flow in one drain, as from the junction of many collateral branches with it, though it be made larger and of greater depth in conſequence of that circumſtance, it may be liable to fail in taking away the water, the effect of which muſt be very extenſive, from the courſe of ſo many others becoming impeded in conſequence of it: it is a good rule, therefore, not to connect a number of drains with the ſame outlet, or diſcharging one; but to form them, eſpecially where there is much declivity in the land, as much as poſſible in a diſtinct and ſeparate manner.

The ſpades employed in forming the drains were formerly made of different ſizes, ſo as to follow each other, narrowing in breadth in a regular manner to the bottom. Lately, however, the plough has been made to ſupply, in the way that has been juſt ſhewn, the places of all of them except the lowermoſt, or the two lowermoſt ones where the drains are required to be deep. Scoops are likewiſe uſeful tools in this buſineſs, as by drawing them along the bottom of the drains all the looſe and detached particles of earth may be cleared away, and they be prepared for the materials with which they are to be filled †. Im-

* See Annals of Agriculture, vol. VIII. p. 164.

† The expence of making drains, it is obſerved by the writer of Mr. Elkington's Mode of Draining, muſt neceſſarily vary, according to the particular circumſtances of the caſe. In the county of Suffolk, as ſtated in the Agricultural Report of the county, the expence of digging out and filling two ſplt drains is from three ſhillings and four pence to three ſhillings and ſix pence a ſcore rods, without any allowance of beer.

But

plements of this ſort of various dimenſions ſhould be had, in order to ſuit the different ſizes of the drains;—repreſentations of which may be ſeen by conſulting the annexed plate.

Various implements of other kinds, in ſomewhat the forms of ploughs, have been invented at different periods for the purpoſe of forming hollow drains at once in land, but hitherto we believe without that general ſucceſs which might be wiſhed for in ſuch inſtruments. That which was not long ago invented by Mr.

But in Eſſex, according to Mr. James Young, they pay for digging out the land drains one ſhilling and eight pence, and for filling them with ſtubble four pence per ſcore rods without beer; and an expert workman, where the land is not ſtony, is capable of digging twenty-three or twenty-four rods in a day, or within working hours.

He eſtimates the expence, or the money that the farmer pays out of his pocket, for draining an acre of land in this way:

	£.	s.	d.
For cutting and raking together an acre of wheat ſtubble, moſtly ſufficient for an acre of drains	0	2	0
Digging eight ſcore rods of drains	0	13	4
Filling them up with ſtubble	0	2	8
Extra work with the common ſpade, averaging a day's work for a man	0	1	4
	0	19	4

It is obſerved by Lord Petre, that the value of the work is different according to the method purſued. His mode is that of ploughing with a common plough, and pair of horſes, two furrows different ways, leaving a baulk in the middle, which he afterwards ploughs out with a large plough, and three horſes abreaſt, which regularly turns a furrow about two inches deeper than the land is commonly ploughed. The expence, without allowing any thing for the perſon who attends, and marks out the ditches, is, he ſays, about one ſhilling and ſix pence per acre, the drains being a rod apart. This is the mode for fallows. The labour of digging is two-pence farthing or two-pence halfpenny the rod, and the expence for the acre of the whole work is, as near as he can gueſs, on a fallow, where two ſpits are dug, four pounds three ſhillings and ſix pence per acre; with the plough, and one ſpit, about three pounds; with the plough, about one pound fifteen ſhillings; without the plough, and the ſpits, on clay ſet, about two pounds ſeven ſhillings per acre.

According to Mr. Majendie's information, his expence is:

	s.	d.		s.	d.
Digging the drains with the ſmall or laſt ſpit ſpade per ſcore yards	1	8	to	2	0
Two ſpits in main drains	3	0	to	3	6

In this manner the under-draining one acre (the drains at one rod apart), including wood, ſtraw, and all other incidental charges, amounts to an expence of from two pounds to two pounds five ſhillings.

It is ſtated by Mr. Kent, in ſpeaking of the conſtruction of drains with the ſpade and the ploughs, that it is rather difficult to make an exact eſtimate of the expence, as the price varies, in the county of Eſſex itſelf, from one penny to three pence per pole, in the workmanſhip only; and ſome land re-

Adam Scot, termed a mole-plough, and which has ſince, perhaps, been in some degree improved by Mr. Watt, of Bingley, may anſwer in ſome particular kinds of ſoil, at certain ſeaſons of the year; but from the great ſtrength which is required to draw it, it is obvious that it can only be employed under peculiar circumſtances of ſoil, ſeaſon, and ſtrength of team. However deſirable it may therefore be, to have an effective implement of this kind, that may be generally made uſe of, and which performs its work at a cheap and eaſy rate, it would ſeem that at preſent the farmer is not in poſſeſſion of one that can be conſidered as fully adequate to the purpoſe.

There is another ſort of inſtrument, invented for the purpoſe of draining, and which has been made uſe of in Eſſex: it is a heavy wheel, with a ſharp cutting edge. In the ſurvey of that county it is remarked, that the wheel is conſtructed of caſt-iron, weighs about four hundred weight, and is four feet in diameter; that the cutting edge, or extreme circumference, is half an inch in

quires the drains to be nearer together than others; but ſuppoſing them to be a pole in width from each other, which is the common diſtance, the following calculation, upon an average, will be pretty exact for an acre:

	£.	s.	d.
Sinking the ditch to obtain an outfall	0	7	6
Drawing the furrows	0	2	6
One hundred and ſixty poles of digging and filling up, at two pence	1	6	8
Wood, eſtimated at a faggot of twelve feet long to a pole, carriage included, at four pence per faggot	2	13	4
Half a load of ſtraw, and carriage	0	7	0
Extra-digging, in the ends, where the plough will not reach	0	1	6
	4	18	6

Mr. Middleton, in his Report of the Agriculture of Middleſex, ſtates the expence of draining on Enfield Chaſe to have been, for

	s.	d.
Common drains, twenty poles eighteen inches deep each	3	0
Principal ditto, two feet deep of the ſame length	5	0
Beer to each ſcore	0	2

The labourer to find tools, and keep them in repair.

The uſual diſtance, a ſhort pole from each other.

In the Report of the County of Kent, the expence of this mode of draining is aſſerted to be from fifteen to thirty ſhillings the acre, according to the number of drains that may be required.

And in the Agricultural Survey of the County of Somerſet, it is ſtated, that main drains two feet and a half deep and two feet wide, in a heavy ſtrong clay ſoil, may be dug for one ſhilling and ſix pence per rope, of twenty feet, viz. nine pence per rope digging the drain and placing the ſtones, three pence per cart-load quarring the ſtones, and three pence per load halling. Each rope requiring one cart-load and half of ſtones.

Small drains, leading to the main drain, may be executed for ten pence per rope of twenty feet.

thickneſs, which increaſes towards the nave or centre. At the depth of fifteen inches it will ſcore or cut out a drain half an inch wide at the bottom, and four inches at the ſurface. It is placed in a frame in ſuch a manner as that it may be loaded according to circumſtances, and be made to cut a greater or leſs depth in proportion to the reſiſtance afforded by the land. After the ground has been ſcored out in this way in the winter, the drains thus conſtructed are then either filled by means of ſtraw ropes, and ſlightly covered with earth, or left to be rendered wider and of greater depth by the cracks produced from their being expoſed to the influence of the ſummer's ſun: the openings being afterwards filled by twiſted ſtraw or bruſh-wood, and lightly covered over with mold or earth, of the moſt porous ſort that can be readily procured. In this way hollow drains are made on graſs or ley grounds at a trifling expence, which from experience have been found to anſwer well. It is likewiſe aſſerted by Mr. Young in the Annals of Agriculture, that twelve acres have been drained in a day by this wheel; and that it is found to execute the work in the moſt effectual manner when the land is ſoft from moiſture. This mode of draining would ſeem to be the moſt adapted to ſuch paſtures and pleaſure-grounds as have conſiderable ſmoothneſs of ſurface, without being trodden by heavy cattle, and which, from the retentive nature of their ſoils, detain the water that falls in rain.

A ſort of plough, termed a *Miner*, and various kinds of common draining-ploughs, have been conſtructed for the purpoſe of opening up tillage-lands to a conſiderable depth, ſo as to allow the water to paſs away upon the impervious clayey material below the common ſurface ſoil. Theſe are repreſented in the annexed plate.

The beſt or moſt proper ſeaſon for performing the buſineſs of hollow-draining, does not ſeem to be yet fully determined by thoſe who have been moſt engaged in the practice; ſome contending that winter is the moſt advantageous time for the purpoſe, while others think that ſummer ſhould always be preferred. It would, however, appear, from the conſideration of the different circumſtances of the lands at theſe periods, that neither of them are the moſt favourable ſeaſons for this kind of work; but that the more early ſpring months, when labourers can be procured, and it does not interfere with the other operations of the farmer, are by much the beſt; as, in theſe, the difficulties ariſing from the hardneſs of the ſoil, and the ſcarcity of labourers, in the ſummer ſeaſon, and the kneading and plaſtering, as well as the cutting of the land by the cartage of materials in the winter, are equally avoided. Beſides, in theſe months the land is not only in the

moſt ſuitable condition for the workmen, but the danger of the new drains being deſtroyed in ſome ſituations by the floods cauſed by the autumnal rains, is guarded againſt.

Where, however, the farmer has a great deal of work of this kind to perform, it will be impoſſible to do it all in theſe early months: he muſt proceed with the buſineſs at other ſeaſons when froſt is not preſent. It is the moſt common practice of farmers to drain ſtubbles in the winter, and fallows in the ſummer months.

Some expert drainers, however, think this ſort of work much better performed when the land to be rendered dry is under a layer, or ſown down with ſeeds of the graſs kind. And it has been remarked that the plough employed for firſt opening the furrows performs better on land in this ſtate *.

As the limits between the wet and dry parts of land can be the moſt readily diſtinguiſhed when it is in ſummer fallow, and the little inequalities of ſurface be moſt eaſily levelled down, that period is by moſt farmers conſidered as unqueſtionably the moſt proper time for forming ſuch drains as are merely to convey away the ſurface wetneſs.

Different ſorts of materials may be employed for the purpoſe of filling drains, to which the drainer will be directed by the eaſe and facility with which they may be capable of being procured. Thoſe in moſt general uſe, are ſtones, wood, ſtraw, heath, and bricks conſtructed for the purpoſe.

Where quarried ſtones are employed, and the drain conſtructed at bottom in the manner of a conduit, the trench ſhould be made ſufficiently wide to admit two ſide ſtones, about ſix inches apart, and of equal height, a flat ſtone being placed over by way of cap; and thus a ſecure drain formed. Another mode of conſtructing ſtone drains, and which has been found conſiderably cheaper and more ſecure, is that of uſing three ſtones of a thin, flat form, placing one againſt each ſide of the drain, ſo as to join at the bottom, and capping or covering them with the third; thus forming a ſort of triangular paſſage for the water. When made in this way, it is ſaid that they are neither

* It is ſtated by the author of Mr. Elkington's Mode of Draining, that "Lord Petre prefers a lay, if laid down level, as he has a plough conſtructed for the purpoſe on very ſimple principles, which with ſix horſes he can plough from ten to twelve inches, and lay the furrows as regular as if they had been done by a ſpade; ſo that after the drain is digged and filled, the furrow can be returned to its place again, and rendered quite level by a heavy roller. He only digs one ſpit fourteen inches deep with the bottom land-ditching ſpade. The expence is 2s. 8d. for twenty rods; the digger returning the furrow to its place. He employs the ſame plough on fallows; but it does not anſwer ſo well in that caſe, as the mold falls down into the furrows. The expence of digging in this caſe is 1s. 2d. for every rod."

ſubject to be filled up, nor to obſtruct the current of water that may paſs along them. They do not, like thoſe formed in the uſual way, cauſe obſtruction by ſinking unequally into the ground; but by ſubſiding in a regular manner all together, keep the courſe for the water free. Beſides, in this mode, a leſs quantity of ſtones is generally required; which is a circumſtance of great importance in many ſituations. The firſt method is, however, only applicable in caſes of ſprings; but this, as well as the mode juſt mentioned, is obviouſly much more expenſive than that of throwing in ſmall ſtones in a looſe manner.

In particular diſtricts, as Eſſex, and ſome other eaſtern counties, where drains are filled with ſtones, they employ the ſmall flints from the chalk or ſtones from gravel-pits, or ſuch as are picked from the land. But it is only in drains of very little extent, and where little water paſſes, that ſuch very ſmall ſtones can be uſed with ſafety and advantage; and as ſtones, of whatever ſize they may be, require a greater width in the bottom part of the drain than where wood or ſtraw is made uſe of, the expence of forming them will be conſiderably more. In every caſe the ſtones uſed ſhould be perfectly clean and free from clay, or any other earthy matter that may adhere to them, and be placed in the drains in ſuch a manner as that none of the mold or earth may get in along with them, which might be detrimental by filling up the holes and crevices between them.

It has been aſſerted by ſome, that drains filled with wood, and covered in the common way with ſtraw or ruſhes, are ſuperior to ſtones or any other kind of materials, for as the wood decays the water continues to paſs. But that when filled with ſtones, and the drains ſtop up, which in time muſt often be the caſe, the earthy matter becomes quite ſolid round the ſtones, from their not decaying, and the paſſage of the water for ever prevented; which is not the caſe where buſhes or wood are employed, an oozing or draining being conſtantly perceptible. Beſides, by a repetition of the buſineſs, and making the drains in a tranſverſe direction to the old ones, the advantage of filtration through the rotten wood is preſerved, and the ſpewing up of old broken and injured drains removed and carried away. It has been further obſerved, that as buſhes form more numerous cavities than either ſtones or poles, they are leſs liable to be ſtopped up, while the percolation or paſſage of the water is promoted more than by ſubſtances of a larger and more ſolid kind *.

Black thorns are preferred by ſome, from much experience, to all other ſorts of

* It has been found that a load of buſhes containing one hundred and twenty faggots, will complete about three hundred and ſixty rods; and a load of ſtraw of one hundred and twenty bottles will do the

materials for the purpoſe of filling drains, probably from their not decaying ſo quickly as many other ſorts of wood, and their affording an eaſy and free paſſage to the water by their buſhy nature.

By ſome it is a practice to employ wood in filling drains, by depoſiting the faggots or bruſh wood which is made uſe of, upon ſmall bunches of wood in the form of billets ſet upright in the bottom of the drain. But though this method is ſaid to have ſucceeded in ſome of the more northern parts of the iſland, and is perhaps capable of being practiſed with advantage in ſuch lands as are not under the ſtate of arable cultivation, it has been found that in ſome caſes the feet of the animals employed in ploughing have ſunk in ſuch a manner as to remove the materials that ſupported the bruſh wood, and by that means obſtructed the paſſage of the water. Where this mode is followed, eſpecially in lands that are to bear the treading of cattle, care ſhould be taken to have a conſiderable thickneſs or depth of earth upon the drains. It is remarked by the reporter of the ſtate of agriculture in the county of Caermarthen in Wales, that the moſt complete method he is acquainted with, is that of cutting the ſtrongeſt parts of willows, and other aquatic plants, into lengths of about twenty inches, and placing them alternately in the drain, one with the end againſt one ſide of the bottom, and the other with it againſt the oppoſite ſide, ſo as to form a ſort of croſs-work. The ſtronger parts of the wood being laid in this way in the drain, the ſpace between on the upper ſide is filled with the ſmall twigs or bruſh wood that has been left, and the whole is finiſhed by a ſlight covering of ſtraw, ruſhes, or ſuch-like ſubſtances, being laid over them. It has been obſerved, that the boughs of willow, alder, aſp, and beech, are extremely durable when put in ſuch drains in their green ſtate before the ſap is dried up; but that when ſuffered to become dry before they are put under the ground, they decay more quickly. The reporter has ſeen willow taken out of a bog where it had laid thirty years, with the bark freſh and ſappy as if juſt cut from the hedge; and it is well known, he remarks, that beech laid in the water green will continue ſound for almoſt any length of time.

It has likewiſe been remarked by an able agricultor, Mr. Majendie, that wood of eighteen years' growth, is much more durable than ſuch as is only ten or twelve.

On filling drains with ſtraw, where the ſoil is a cloſe retentive clay, it is ad-

ſame: the buſhes are moſtly worth fourteen ſhillings, and the ſtraw eighteen ſhillings, the load. The expence is therefore eſtimated at about twelve ſhillings an acre, the ditches being made about a rod diſtant from each other.

viſed that the drains ſhould be made near to each other, ſhallow, and filled with that material only, as it is quite unneceſſary to employ wood or other more durable materials, where the ſides of the drains are not likely from the nature of the land to crumble down into them. In ſuch caſes, the diſtance of the drains ſhould ſeldom be greater than three or four yards from each other, and about twenty inches in depth; or ſuch as may be eaſily produced by firſt uſing the plough, then ſhovelling up the bottom of the loweſt furrow, and afterwards taking out one ſpit with the land-ditching ſpade: drains formed in this way, with the materials, coſt about two ſhillings and ſix pence a ſcore rods.

It is further remarked, that drains cut through tough retentive clays, and managed in this way, will be found ſoon after they have been made to have formed over the ſtraw employed in filling them, an arch of ſuch ſtrength as to ſupport the weight of the ſoil, and any thing that may come upon it in the courſe of managing the land; and that in the courſe of twelve or eighteen months, from the ſtraw being an uniform ſubſtance, it is wholly rotted and conveyed away, leaving clear open pipes in ſuch drains, as the water may have had a free and eaſy paſſage into, by a proper attention having been paid to the filling of them with the moſt open and porous parts of the ſurface of the land *.

But the beſt method of filling hollow drains with ſtraw is probably that which has been lately practiſed of twiſting it into ropes. The mode which has been moſt generally followed, is that of treading into the drains looſe ſtraw; but it may be forced much more effectually to the bottom of the drains, and convey the water away much more readily, and be alſo of much longer duration, by being wound into a firm hard rope, about the ſize of a ſmall cable, while the buſineſs of filling the drains is rendered more expeditious, and the quantity of ſtraw which is neceſſary not by any means increaſed. This method has been practiſed by Mr. Bedwell, in the county of Eſſex, with great ſucceſs and advantage, and who has found that the ſtraw is tougher and in a better condition for winding after it has been picked over by cattle, than in its freſh and dry ſtate. A repreſentation of a machine for this purpoſe may be ſeen in the annexed plate.

Bricks are ſometimes made and employed for the purpoſe of draining, but they are in general too expenſive, and not well ſuited to ſurface draining, though they are proper for ſuch drains as are to carry off the water iſſuing from ſprings, in which caſes a large tract of land may frequently be laid dry, without employing any very great quantity of ſuch materials. The bricks uſed in this way have moſtly

* See Vancouver's Report of the County of Eſſex.

an excavation for the water to paſs along, and are placed in ſtiff ſoils upon the bottom of the drains; but in ſuch as are ſoft, they are moſtly laid one upon the other, ſo as to form a ſort of cylindrical paſſage for the water; or they may be placed on a foundation made of common bricks: repreſentations of bricks for this uſe may be ſeen in the plate.

Pipes made of burned clay, about eighteen inches in length, having an opening three or four inches in diameter, are alſo made uſe of in this way in the county of Eſſex, and ſome other diſtricts; but from the narrowneſs of their apertures they can only convey a ſmall quantity of water, they are therefore more ſuited to the conveyance of water from ſprings or other places for domeſtic uſes, than for the purpoſes of draining land.

As it is a matter of conſiderable importance in the buſineſs of draining, to have the work properly executed, on this account the perſons who perform the cutting of the drains ſhould not be contracted with for the filling of them, but merely for the cutting and leaving them clean in the bottoms. The filling being performed by labourers hired by the day, in order to guard more effectually againſt negligence, and the want of proper attention to the work; and even when done in this way, either the farmer himſelf, or ſome other perſon who can be truſted, ſhould frequently inſpect the performance. It is obſerved by an ingenious drainer, that it is an invariable rule with him never to ſuffer the man who digs to cover up the drains, they being left for him or his bailiff to inſpect; they are then filled up well to the ſhoulders with wheat ſtubble, cut and ſtacked for the purpoſe immediately after harveſt; and a ſmall ſtick or two put at the outlets to prevent their being ſtopped up by accidents: after this he turns a furrow of the upper ſoil or mold upon the drain by means of a common plough, taking care not to turn in any of the dead ſoil brought up by the land-ditch ſpade, which ſhould always be laid on the outſide, and be ſpread over the land. It is proper, he ſays, not to let the drains lie open any great length of time, as they may get injured by wetneſs or froſt; his general rule is to fill them up in the courſe of the day *. By conſulting the annexed plate, the methods of filling drains in different caſes may be better underſtood.

Methods of draining mines, quarries, and pits.—Beſides the removing the injurious wetneſs of land ariſing from ſprings, and that on the ſurface cauſed by the ſtiff and retentive nature of the ſoil, there is another application of the principles which have been explained, which is in the draining of mines, quarries, and

* Mr. James Young, of Clare.

ſuch pits as have been formed in the digging of marl or other ſubſtances of a ſimilar kind, where they are prevented from being wrought by it.

As the injurious water is brought down from the more elevated ſituations through the porous ſtrata of materials at conſiderable depths, as has been already ſhewn; where pits, mines, or quarries, happen to be formed at the bottom of ſuch declivities, and are inconvenienced or wholly obſtructed, either in the digging or working, by the water contained in them, it may be poſſible, in many caſes, to prevent its coming into ſuch mines or pits, by cutting or boring into the loweſt edge of the porous ſtrata where the level of the ſituation in which it is, is lower than where it lies in the pit or mine. In order to accompliſh this object, it will be neceſſary to aſcertain if any porous ſtratum preſents itſelf higher up the elevation than the place where the mine or pit is formed, that may conduct the water it poſſeſſes to the porous body that is below it; as where ſuch a ſtratum is diſcovered by cutting into it, much of the water may be drawn off and prevented from paſſing down. But, notwithſtanding the water from above may be cut off in this way, a quantity ſufficient to inconvenience the working of the mine or pit may ſtill filtrate from the ſides of the porous bed, even though it may incline in the direction of the lower ground. When this is the caſe, it may, however, be readily taken away at ſome place in it. To accompliſh this, and thereby obviate the effects of the water, the termination of the porous ſtratum below the pit muſt be aſcertained; and where there is any mark of a natural outlet at the place, a large drain ſhould be formed, in order to admit the water to flow off with more expedition. Where, however, there is a thick bed of ſome impervious ſubſtance, ſuch as clay, placed upon the termination of the porous material, the drain need only be cut a little way into that, as by boring through the reſt a ſufficient paſſage may be given to diſcharge the water. In this way, the draining of ſuch grounds as lie above or near to mines or pits, may be of great advantage *.

In reſpect to the removal of the water contained in the bottom of ſuch mines or pits, another method of proceeding is recommended; as the level of the ground may probably be no-where lower than that of the opening of the pit. It is ſolely in caſes where the direction of the ſtrata and porous materials have an inclination with the ſurface, or lie horizontally, that ſuch a mode as that which has been juſt deſcribed can be employed with advantage. In inſtances where the direction of them is the contrary of the above, the only chance of

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 78.

removing the water is by diſcovering their terminations on the other ſide of the elevation, which may in many caſes be in ſome meaſure aſcertained by a careful uſe of the level, and a nice obſervation of the manner in which the ſtrata of mine or pit lie. But this will be much better comprehended by conſulting the annexed plate.

This is the manner of obviating the effects of water in ſinking the mines or pits; but a different mode is to be purſued in removing that which is met with in the bottoms of the pits or mines, or which iſſues from the rocky ſtrata on their ſides. Here the aid of machinery of the pump kind becomes neceſſary, the operation of which may frequently, as where the uſual ſtream is inſufficient, be aſſiſted by the water proceeding from the drains that have been juſt mentioned, and which is more fully ſhewn in the plate. It may alſo be further uſeful in raiſing the products from the mines or pits in ſituations which are ſuitable, and where a full command of it can be had. Another mode of removing water in theſe caſes is, by digging or boring in the bottoms of ſuch pits, and thereby letting down the water into the porous materials below where they exiſt. This is a method that has been practiſed with ſucceſs in different ſituations*.

In raiſing ſtone from quarries, it not unfrequently happens, that much obſtruction and inconvenience is produced by water breaking in when the workmen come to ſome depth, from the rocky ſtratum in which it has been confined; and which it has been uſual to remove, either by means of expenſive machinery of the pump kind, or very deep and troubleſome cuts, made under the level of the water from the neareſt ſituations that will admit of them. But as in theſe caſes it moſtly happens that the water is pent up and confined, both below and on the ſides of the rock, by ſome impervious material, ſuch as clay, ſo as to keep it full and prevent its flowing off; it may be more eaſily, and with much leſs expence, carried away by cutting a drain through the impervious material that incloſes it on the moſt depending ſide; which may frequently be diſcovered by the nature of the ſurface-ground and the uſe of the level. This will alſo, at the ſame time, have the effect of rendering the ground that is near it dry. And in other caſes of this nature, where the water ſinks down through the porous or fiſſured ſtratum of ſtone, and is confined by a cloſe and compact one below, which has ſand and gravel or other porous materials beneath, it may be conveniently removed by boring or digging through the compact ſtratum, and thus letting the water down. This method is ſaid to be particularly advantageous where the termination of the rocky ſtratum, which is generally compoſed of looſe frag-

* See Agricultural Report of the County of Hertford, p. 67.

ments of ſtones of the ſame kind, with ſand, to ſome depth, and of the nature of quickſand, is to be cut through *.

In marle-pits alſo, which, from the nature of their ſituation, moſtly require much cutting through ſome part of their ſides, in order to remove the water that prevents their being wrought, the mode of letting the water down by means of pits dug through the upholding ſtratum below the bed of marle into the porous materials underneath, might be economically practiſed. In ſuch caſes, the number of the pits muſt be proportioned to the ſpace occupied by the marle; and when they are required to be of ſuch depths as to be liable to give way, they ſhould be built up, or nearly filled with looſe ſtones, ſo as to admit the water to paſs off; ſuch lateral drains as are neceſſary communicating with them.

In ſome ſituations of the pits, as where the bank ſlopes lower on the contrary ſide than the level of the water, an eaſier mode may be practiſed; ſuch as by forming a drain in it, and then perforating with a horizontal boring inſtrument into the terminating part of the ſtratum that holds the water; thereby removing and keeping it below the level of the marle. And in addition to theſe, in ſome caſes, as where the water of ſuch pits proceeds from ſprings in the high grounds above them, it may be uſeful to intercept and convey it away before it reaches the marle-pits.

The principles that have been already mentioned reſpecting the nature and direction of the different ſtratified materials that conſtitute the earth to a conſiderable depth below its ſurface, have likewiſe another application in the raiſing of water in wells; as upon a full and exact comprehenſion of the variation of them, in the different caſes in which attempts of this ſort are to be made, muſt, in a great meaſure, depend the ſucceſs of the operator; as has been ſufficiently ſhewn by the various accounts of ſinking them in particular ſituations, that have been preſented to the public †.

On theſe principles may be explained the reaſon, in digging wells, that if ſtrata of ſand, gravel, or other looſe porous materials be firſt met with, water can ſeldom or ever be found until clay, or ſome other impervious ſubſtance, be reached; or, where clay or other impervious material is begun with, until the the operator has dug down or proceeded to a bed of ſome porous ſubſtance, ſuch as rock, ſand, or gravel ‡.

They alſo ſhew, that by digging wells in particular ſituations, in valleys or level grounds, where the water deſcends between the ſtrata from a diſtance at

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 48.

† See Anderſon's Treatiſe on Draining. ‡ Ibid. p. 69.

a great height, by building up, or otherwiſe raiſing, the top of the well, ſo as that it may not give way by the preſſure of it;—it may be raiſed to a conſiderable height above the ordinary level of the well;—and thus, in many caſes, be rendered more uſeful than it could otherwiſe be. Curious inſtances of this nature have been frequently noticed by writers *. And further, that by widening the bottoms of wells in ſome caſes, as where the water filtrates between the ſtrata in too ſparing a quantity, it may be augmented nearly in a ſimilar proportion to the extent of the opening †. Practical examples of theſe kinds may likewiſe be met with in the Philoſophical Tranſactions.

As from the ſtagnation and retention of too much water, in or upon lands, whether in the ſtate of tillage or that of graſs huſbandry, much injury muſt be produced;—in the firſt caſe, by its rendering the ſoil too moiſt and poachy for being ploughed up ſufficiently early for many ſorts of grain crops, and for the manure being properly incorporated and preſerved in it; and in the latter, by the cold which it cauſes in the winter ſeaſon, rotting, weakening, and thereby rendering the abſorbent roots of the graſſes incapable of performing their offices;—it is obvious, that the operation of draining muſt conſtantly be effectually performed, before any other ſort of improvement can be attempted with the leaſt proſpect of ſucceſs: until this has been fully accompliſhed, it is indeed impoſſible to know whether the land be ſuitable for the growth of crops, or what benefits may be produced in it by the application of manures. And, as the removal of ſuch degrees of wetneſs as prove detrimental to lands, conſtitutes in moſt caſes, and eſpecially in thoſe of the fenny and boggy kinds, an improvement that muſt be of great utility and duration ‡, it would ſeem pro-

* See Johnſtone's Account of Elkington's Mode of Draining Land, p. 70.

† See Darwin's Phytologia.

‡ Vaſt improvements in the quantity and value of lands have been made by this means in different diſtricts. Mr. Young inſerts the following Table on the authority of Mr. Parkinſon, as improvements in drainage, by acts in which he was a commiſſioner in Lincolnſhire.

	Acres.	Improved value.	Old value.	Improvement.
Tatterſhall embankment - -	892	£. 838	£. 387	£. 450
Alnwick Fen - - - -	1,097	709	54	648
The nine embanked Fens to Lincoln	19,418	15,534	1,941	13,592
Holland Fen eleven towns - -	22,000	25,300	3,600	21,700
	43,407	42,375	5,982	36,390

And

per that the proprietors ſhould, in moſt caſes, be at the principal expence of the buſineſs, as it is ſeldom performed in an effectual manner when undertaken by tenants, unleſs they are unuſually ſpirited, or have ſuch length of leaſes as affords them the certainty of obtaining the full reward of their exertions. When this ſort of improvement is made in the early period of a leaſe, it would, however, be proper in the proprietors to demand a ſuitable intereſt on the ſum advanced, and upon a renewal, to have it added perhaps in the way of rent.

From the whole of the facts and circumſtances that have been mentioned, concerning the nature of the different ſtrata that conſtitute the earth, the directions in which they are depoſited in it, and the manner in which water is carried down, confined, and forced to the ſurface of ſoils, ſo as to become, in different ways and degrees, injurious, it would ſeem evident, that ſprings of ſuch kinds as can be in any material degree detrimental to land, need never be apprehended where there is a great depth of porous materials, ſuch as ſand or gravel, without the intervention of clayey or other impervious ſtrata; or in the contrary ſituation, as where the clayey, marly, or other impervious body, extends to a conſiderable depth. This is a matter that ſhould, therefore, be conſtantly kept in the minds of thoſe engaged in the buſineſs of draining lands. And, that where the miſchief proceeds from ſuperficial wetneſs, cauſed by the ſtiff, retentive nature of the ſoils, there muſt be particular attention paid to the nature

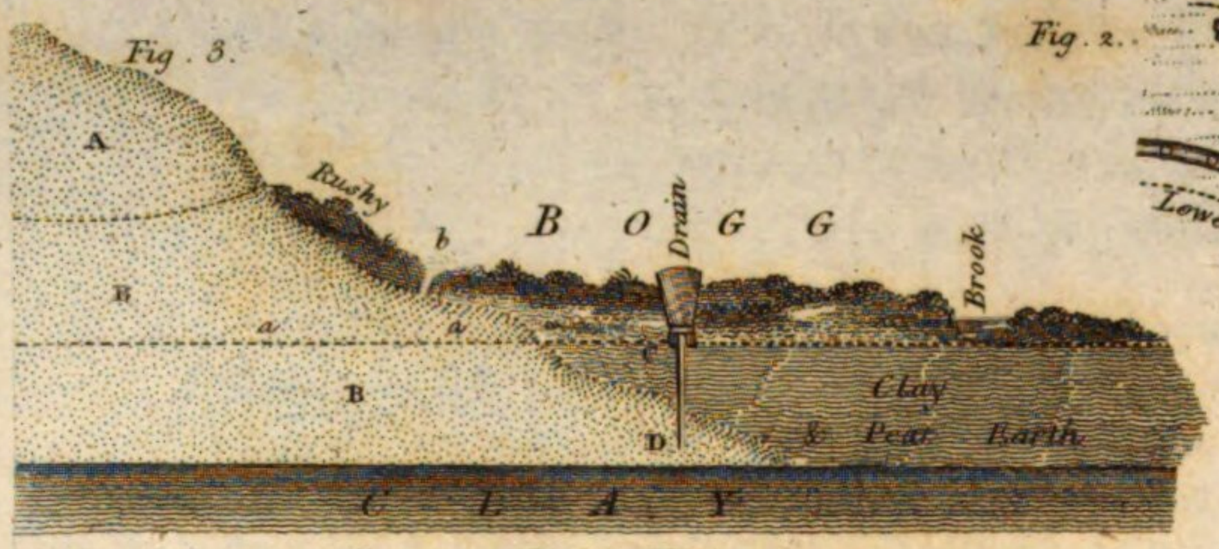
And it is further remarked, that from this view of the drainages in the ſouth-eaſt diſtrict of the county, united with the improvements on the Ancholm, and in Axholm, it will appear that there is not probably a county in the kingdom that has made equal exertions in this very important work of draining. The quantity of land thus added to the kingdom has been great; fens of water, mud, wild fowl, frogs and agues, have been converted to rich paſture and arable, worth from 20*s.* to 40*s.* an acre: health improved, morals corrected, and the community enriched. Theſe, when carried to ſuch an extent, are great works, and reflect the higheſt credit on the good ſenſe and energy of the proprietors. Without going back to very remote periods, it is aſſerted that there cannot have been leſs than 150,000 acres drained and improved, on an average, from 5*s.* an acre to 25*s.*; or a rental created of £.150,000 a-year. But ſuppoſe it only £. 100,000, and that the profit has, on an average, been received during the period of thirty years, the rental has in that time amounted to three millions, and the produce to near ten; and that when, with the views of a political arithmetician, we reflect on the circulation that has attended this creation of wealth through induſtry, the number of people ſupported, the conſumption of manufactures, the ſhipping employed, the taxes levied by the ſtate, and all the claſſes of the community benefited, the magnitude and importance of ſuch works will, it is ſaid, be ſeen, and the propriety well underſtood, of giving all imaginable encouragement and facility to their execution.

By means of drainage in boggy and other ſorts of waſte lands that are too wet for the purpoſes of

vation in various places, improvements to a very conſiderable extent have alſo been effected; in many inſtances raiſing the value of the land from almoſt nothing to 15*s.* or 20*s.* the acre; as may be ſeen by conſulting the different Reports of the Board of Agriculture.

Fig. 1.

Fig. 3.



A. Dry porous Soil, receiving the Rain Water.
B.B. Gravel &c. containing Springs.
a.a. Level of Drains orifice at the Brook.
b. Outlet of Springs.
c. The Water breaks out when the Springs are full.

Fig. 2.

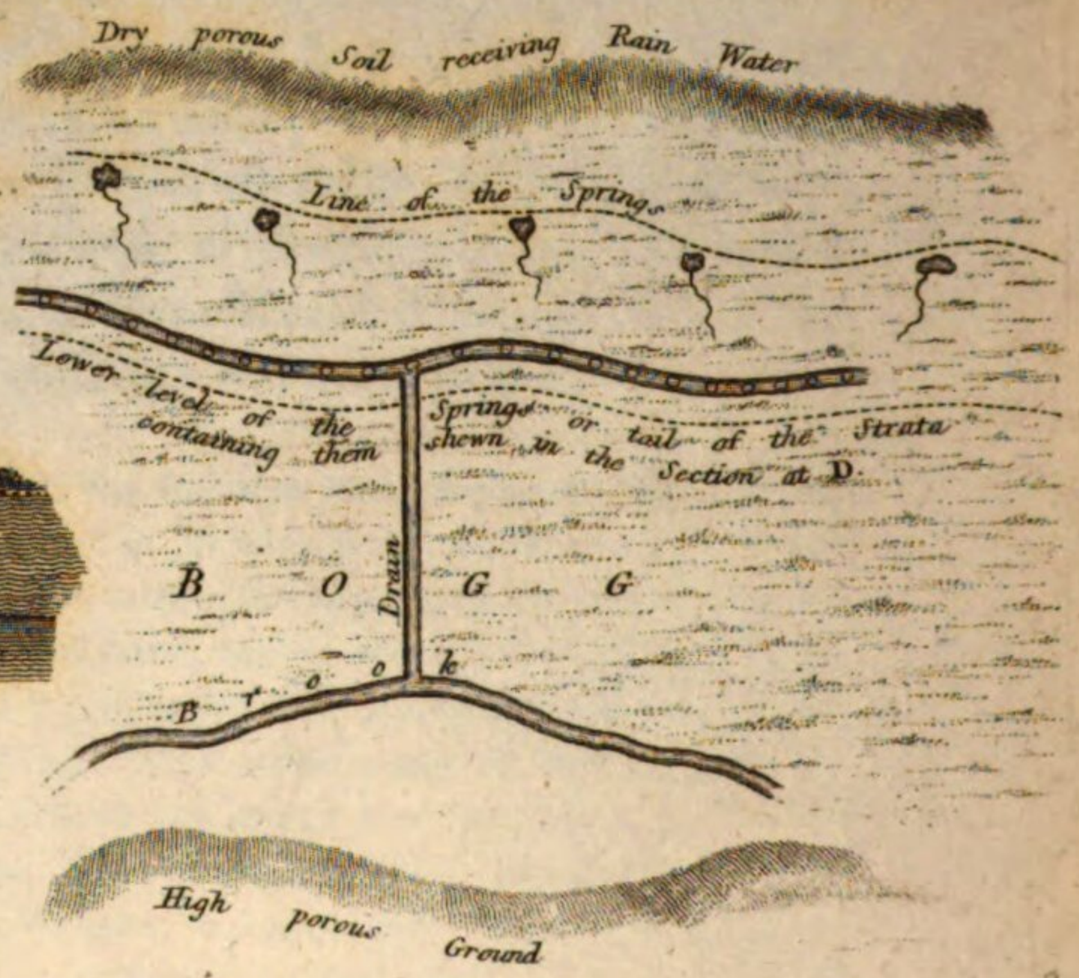
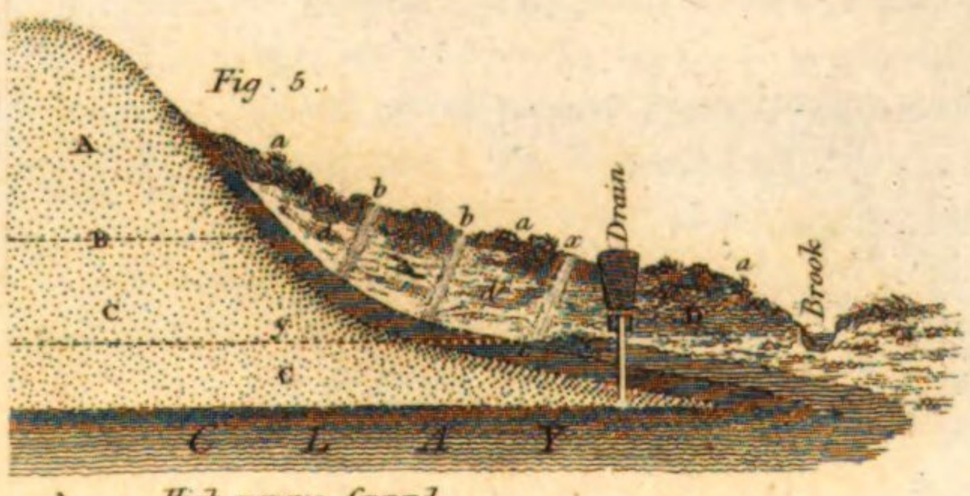
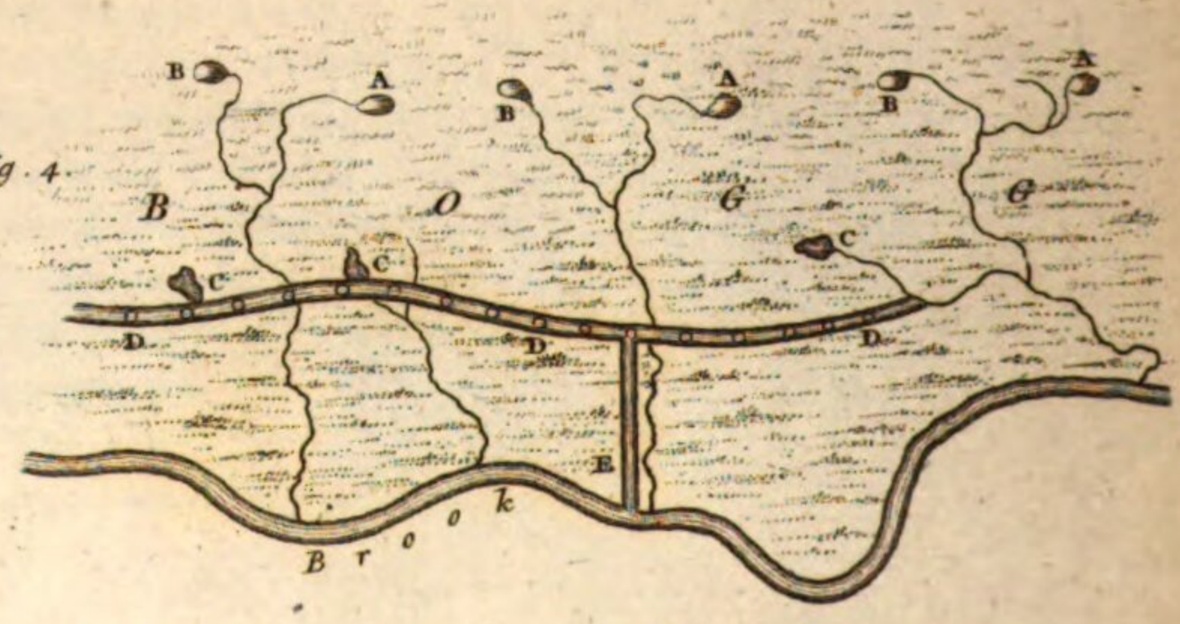


Fig. 5.



A. High porous Ground.
B. Upper level of the Water.
C.C. Gravel &c containing Springs.
D. Outlet.
a.a.a. Boggy Surface.
b.b. Springs.
c.c. Clay
d.d. Peat Earth.
x. Main Spring.
y. Level of the outlet.

Fig. 4.



A.A.A. Springs.
D.D.D. Drain cut along the Level of the lower Springs.
E. Outlet.

PLATE XXXIX.

Drainage of Boggy Lands from Springs.

[*To face Page* 333.]

Fig. 1. Shows the manner in which the ſtrata of hills or elevated grounds are diſpoſed, and broken or interrupted in their directions to the lower lands or valleys: A, the ſhorteſt method of boring for reaching an inferior ſtratum.

Fig. 2. Explains the method of draining practiſed by Mr. Elkington in the firſt caſe of ſpring bogs, as delineated by Mr. Johnſton.

Fig. 3. Is a ſection of the ſame drainage, when the ſtratum of clay, where the trench is cut, is thicker than the level of the orifice will permit the depth of the drain to be, A being the depth of it at that level. The reſt of the clay, from A to B, is to be perforated by an auger to the lower point of the porous ſtratum at D, when the water will riſe up in the trench from the preſſure above the level of the drain.

Fig. 4. Repreſents the mode of drainage in the ſecond caſe of ſpring bogs on Mr. Elkington's principles, as explained by Mr. Johnſton.

Fig. 5. Is a view or ſection of the ſame.

DRAINAGE OF BOGGY & WET LANDS.

Fig. 1.

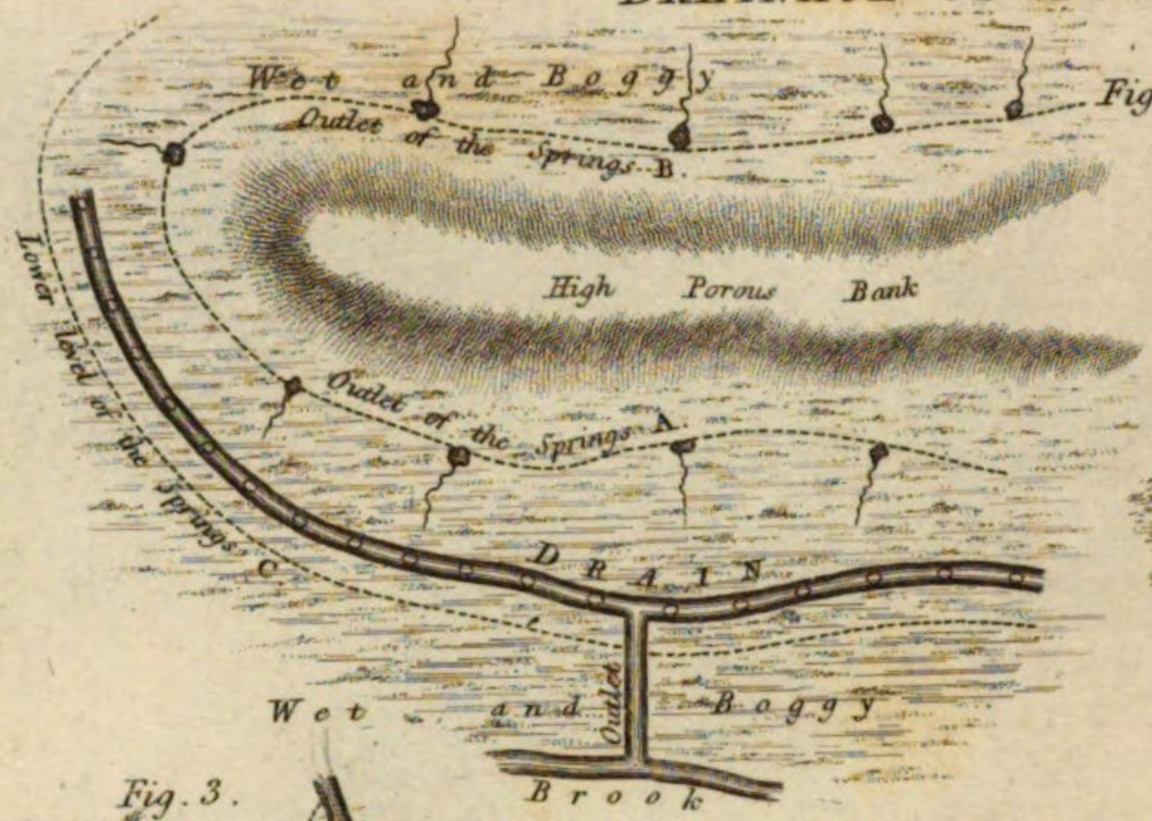


Fig. 2.

a. Level of Drains bottom & outlet.
b. Reservoir of the Springs.

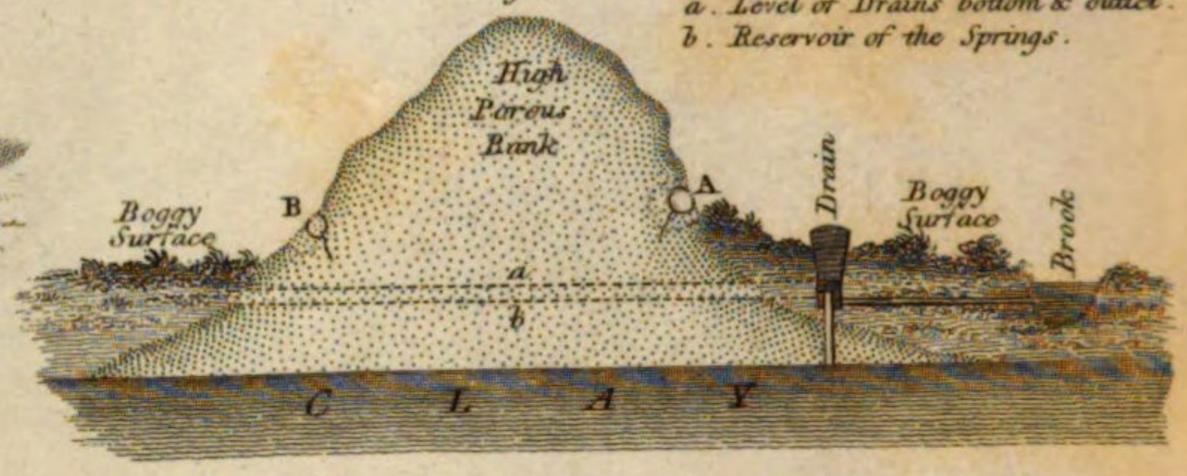


Fig. 3.

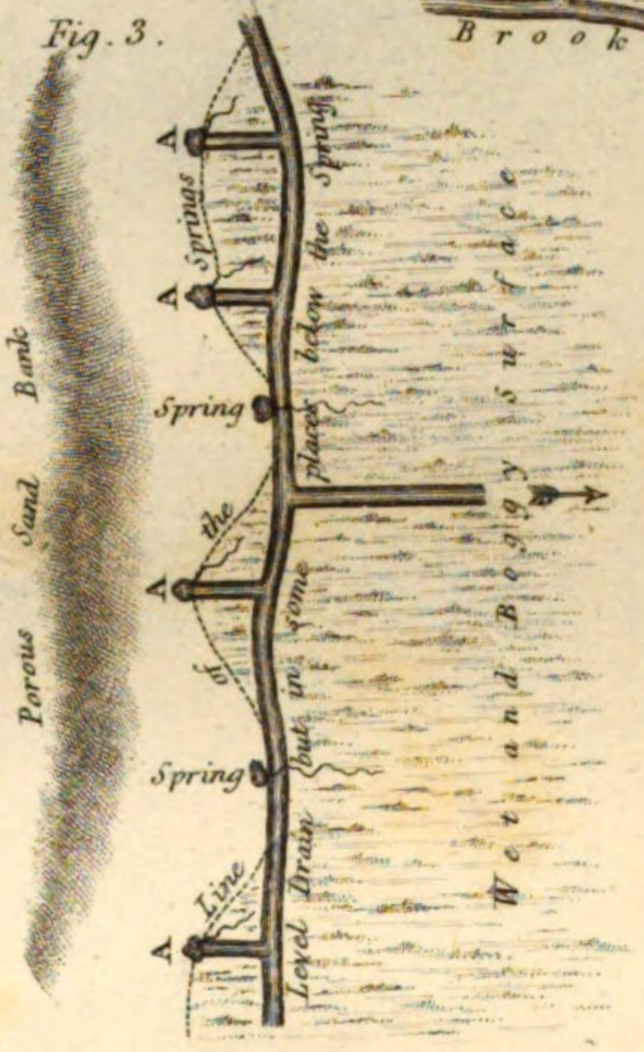


Fig. 4.

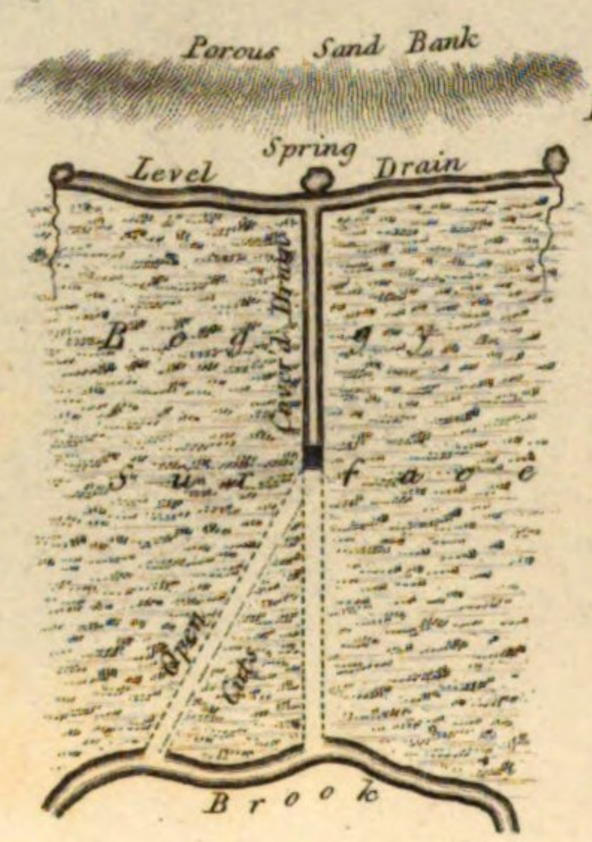


Fig. 5.

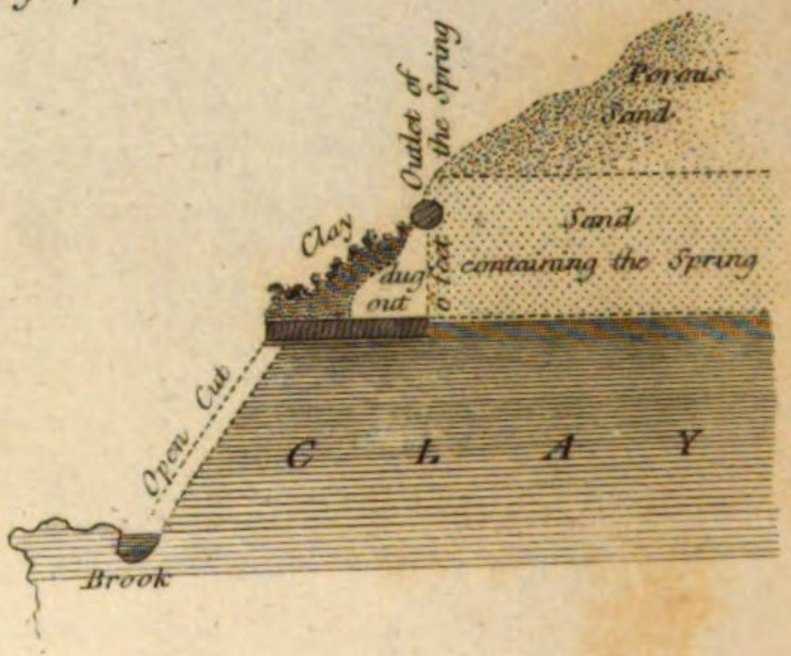


Fig. 6.

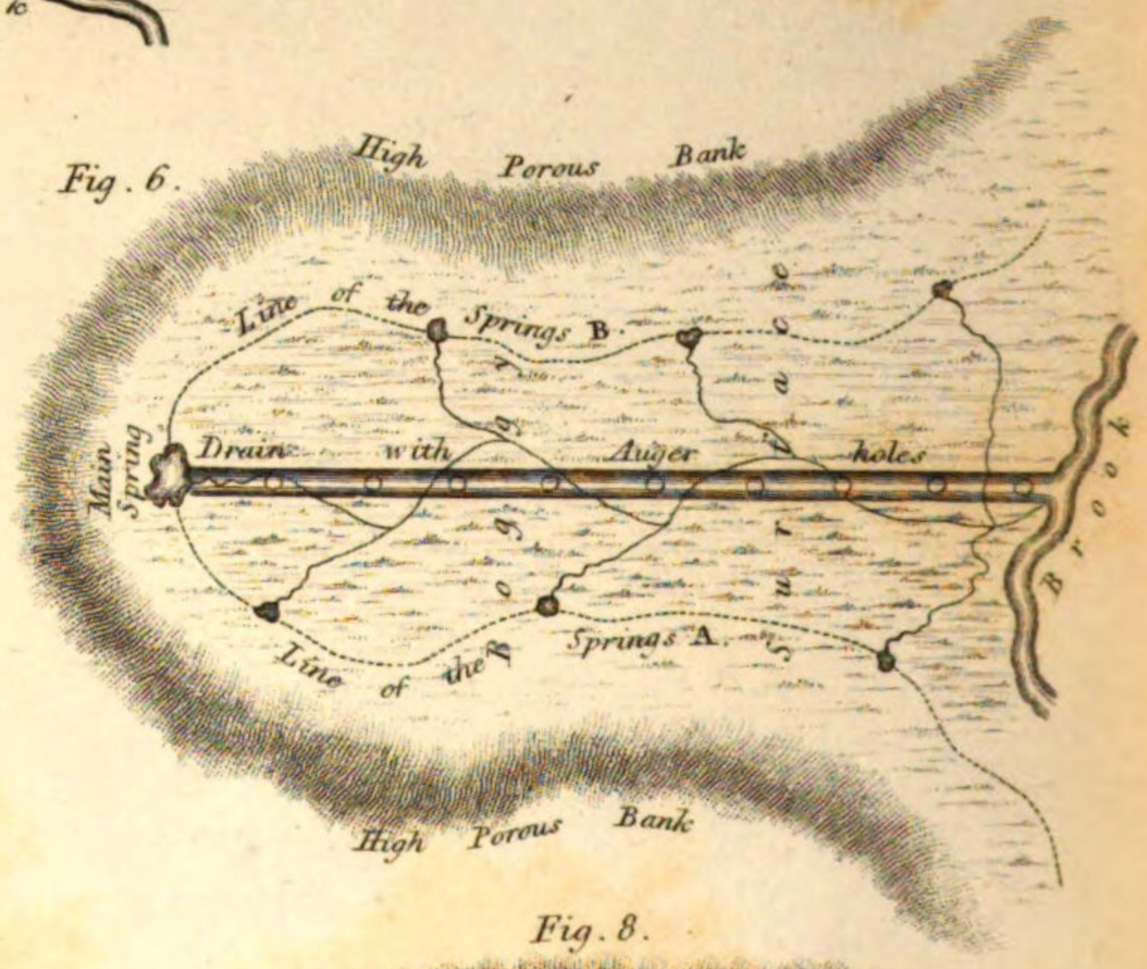


Fig. 7.

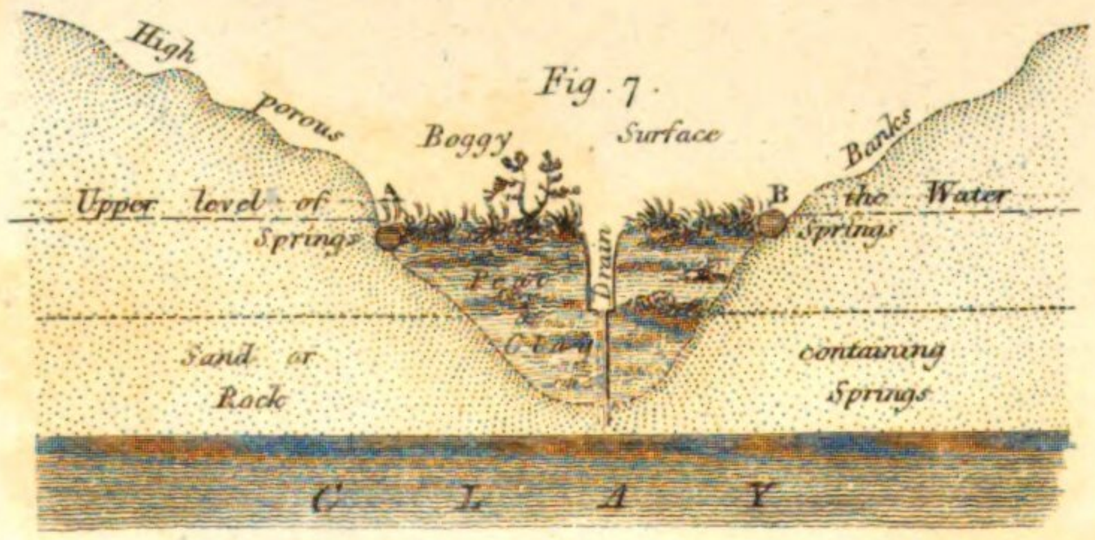


Fig. 8.

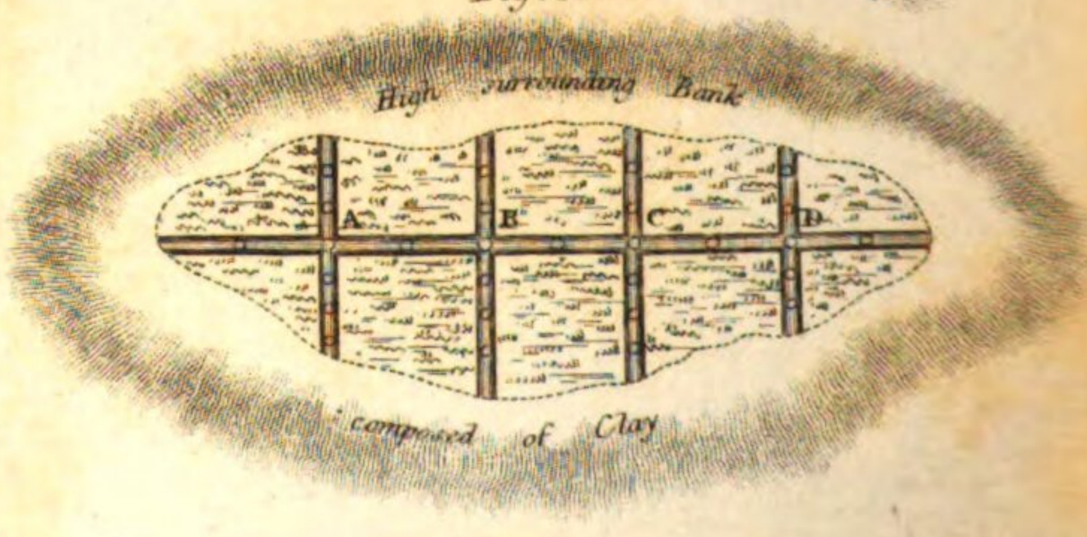


Fig. 9.

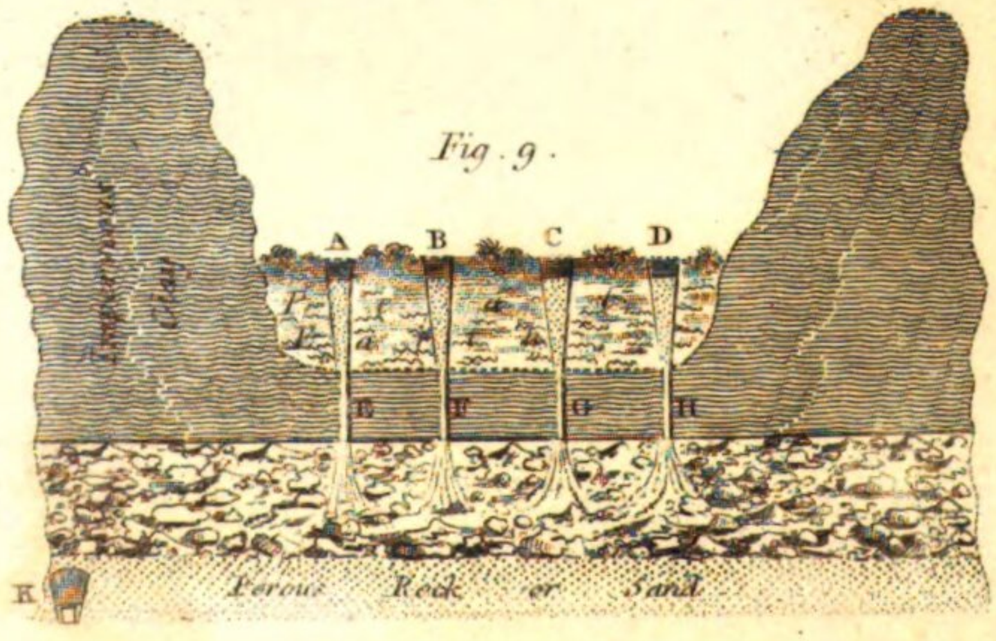


PLATE XL.

Drainage of Boggy and Wet Lands.

[*To face Page* 332.]

Fig. 1. repreſents the plan of draining purſued by Mr. Elkington in hilly ſituations, or where there are high banks, with wet grounds below.

Fig. 2. Is a view or ſection of this drainage, as given by Mr. Johnſtone.

Fig. 3. Is the repreſentation of the plan of draining where the banks are irregular.

Fig. 4. Shows the manner of cutting and managing the drains in this caſe. And

Fig. 5. Is a ſide view or ſection of the ſandy bank.

Fig. 6. Explains the method of draining of bogs where the ſand-banks unite. Where the bog has a deſcent from the ſide A A to the ſide B B, a drain cut on the ſide A A may be ſufficient for the purpoſe.

Fig. 7. Is a front view of this drainage.

Fig. 8. Exhibits the plan of another method of drainage, recommended by Mr. Elkington, in boggy or ſpots of marſhy land injured by ſtagnant moiſture, but where ſprings do not exiſt. This is by letting the water down into the porous ſubſtratum below by perforating through the retentive body above.

Fig. 9. A front view or ſection of this drainage: A B C D here, as in the plan, repreſents the drains cut through the boggy earth, and filled up to within a foot and half of the top with looſe ſtones.

E F G H ſhows the perforations of the auger through the clayey ſtratum, and the deſcent of the water into the rocky or porous ſtratum below.

K, the place where a cut ſhould be made for draining off the water where the land declines ſufficiently, and the porous ſubſtratum is ſaturated with it ſo as to throw it on the ſurface through the perforations.

DRAINAGE OF LOW SWAMPY LANDS.

Dry Ground

Line between the Wet and Dry Ground

D Open or Covered Drain D to cut off the Springs D

Flat Swampy Ground

Ditch Ditch Ditch

Open Drain

Mill Lead

Open Drain

Damhead or Wear

Ground well adapted for Irrigation

River or Brook

Open Drain

A B

Fig. 4.

A B

Fig. 2.

3 Feet

Earth Filled in

4 Feet

Turf inverted
A few small Stones above the Cover

a. the Slough

a

18 In.

Auger Hole

Fig. 3.

Sur face

3 Feet

Drain

1 Foot

Auger Hole

Fig. 1.

PLATE XLI.

Draining of low ſwampy Lands.

[*To face Page* 333.]

Fig. 1. Shows the manner of digging into the ſides of the drains, where ſoughs are laid in running ſands, and the auger employed, as the holes in this way are leſs interrupted by the currents.

Fig. 2. Is a ſection, ſhowing the manner of laying the ſough and covering it.

Fig. 3. Shows the manner of forming the auger holes ſo as to be higher than the bottom of the drains, in hilly ſituations.

In the plate a plan is given of Mr. Elkington's method of accompliſhing the purpoſe of draining in low ſwampy lands on the ſides of rivers, in which the advantages that may be gained, in ſome caſes, by irrigation are likewiſe ſhown.

Fig. 4. Shows the manner of draining where the water is dammed up as a mill-head, being a trough ſeveral feet longer than the width of the dam on each ſide, as ſeen by A and B in the plan. It is ſecured by ſtakes driven into the earth on each ſide with croſs bars above, as repreſented in the figure. The ſpace between the top of it and bottom of head is to be well rammed with clay. A cut is alſo neceſſary, on bank of head, for ſecuring water.

DRAINAGE OF HILLY LANDS & MIXED SOILS.

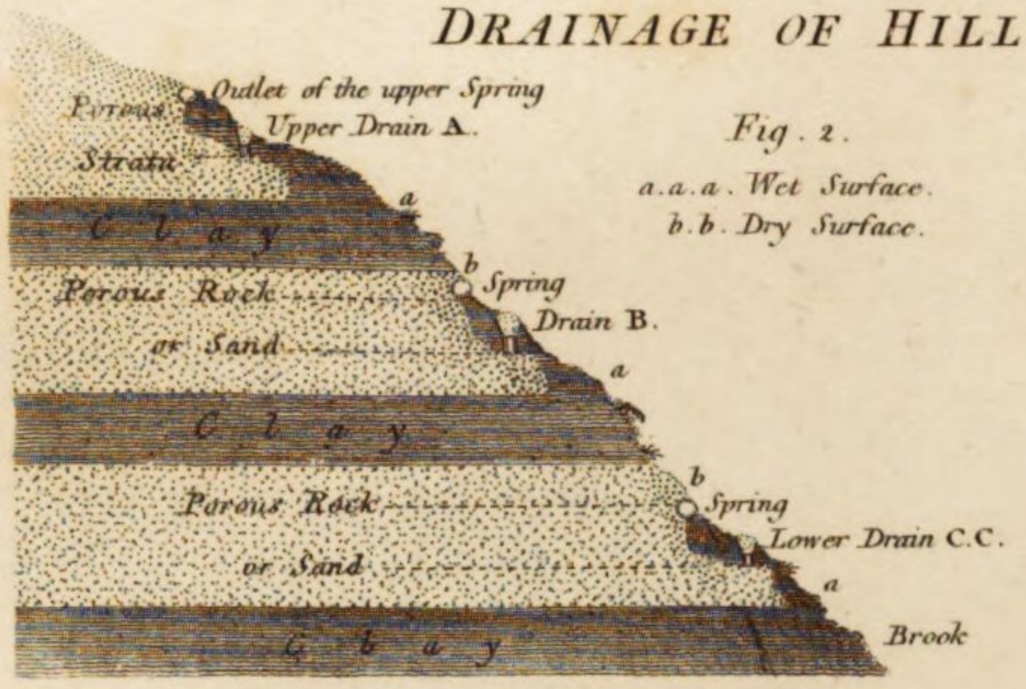


Fig. 2.

a.a.a. Wet Surface.
b.b. Dry Surface.

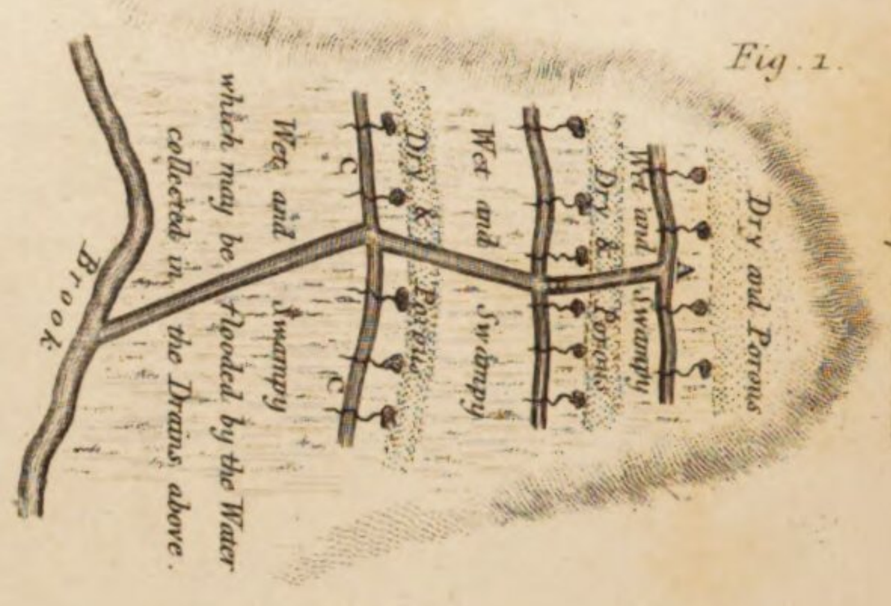


Fig. 1.

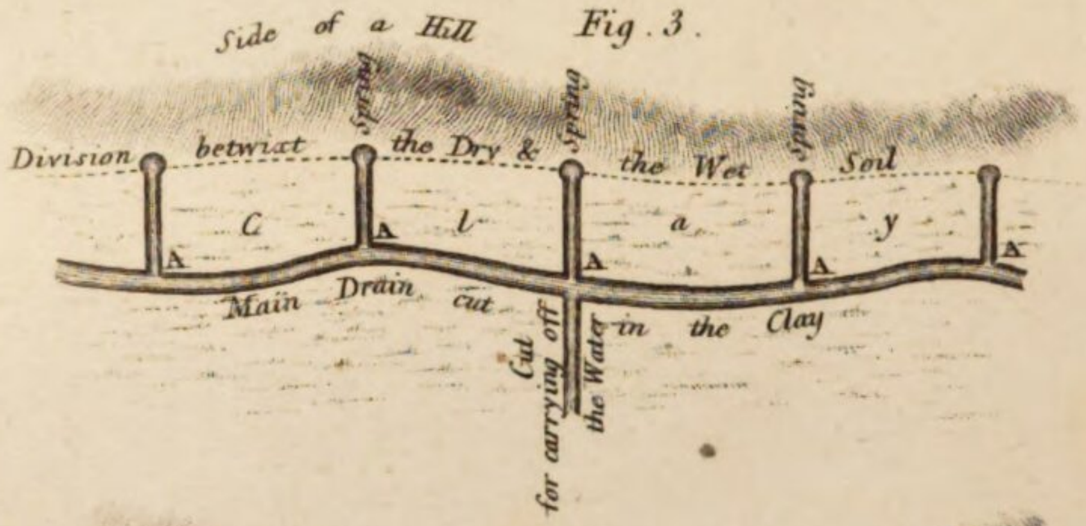


Fig. 3.

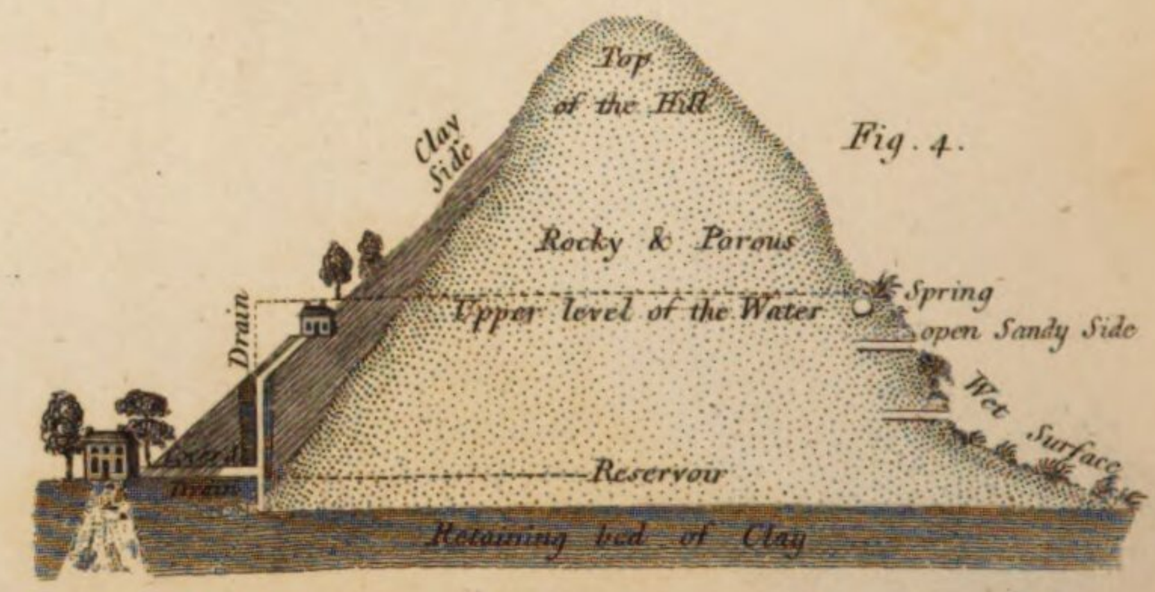


Fig. 4.

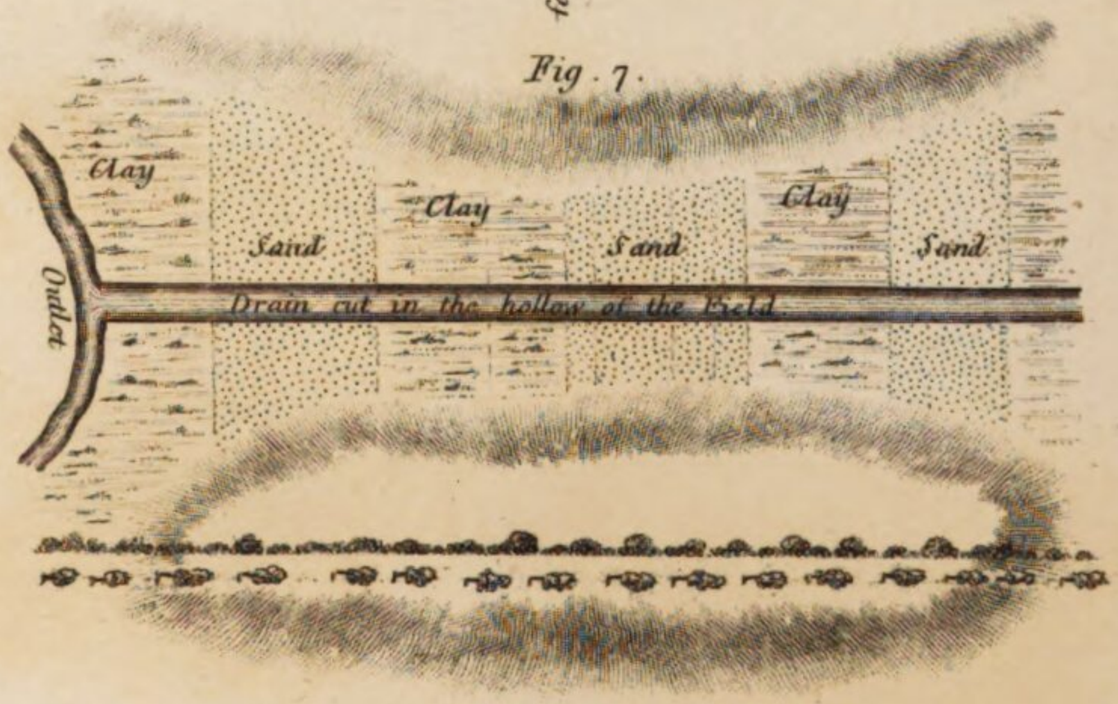


Fig. 7.

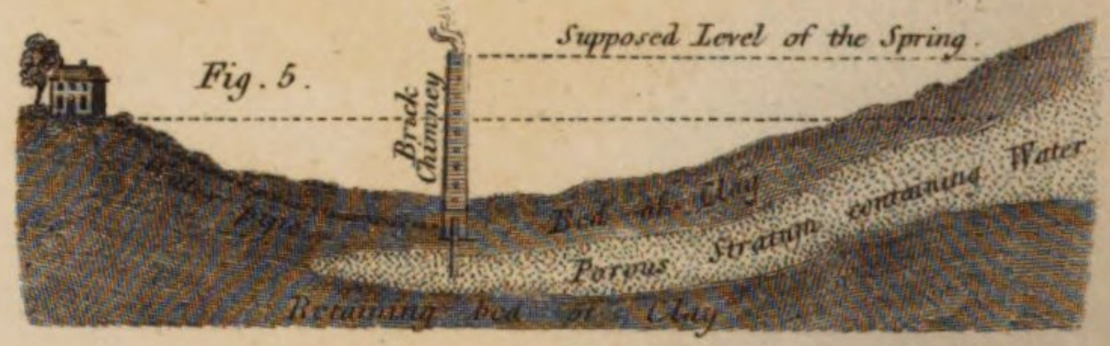


Fig. 5.

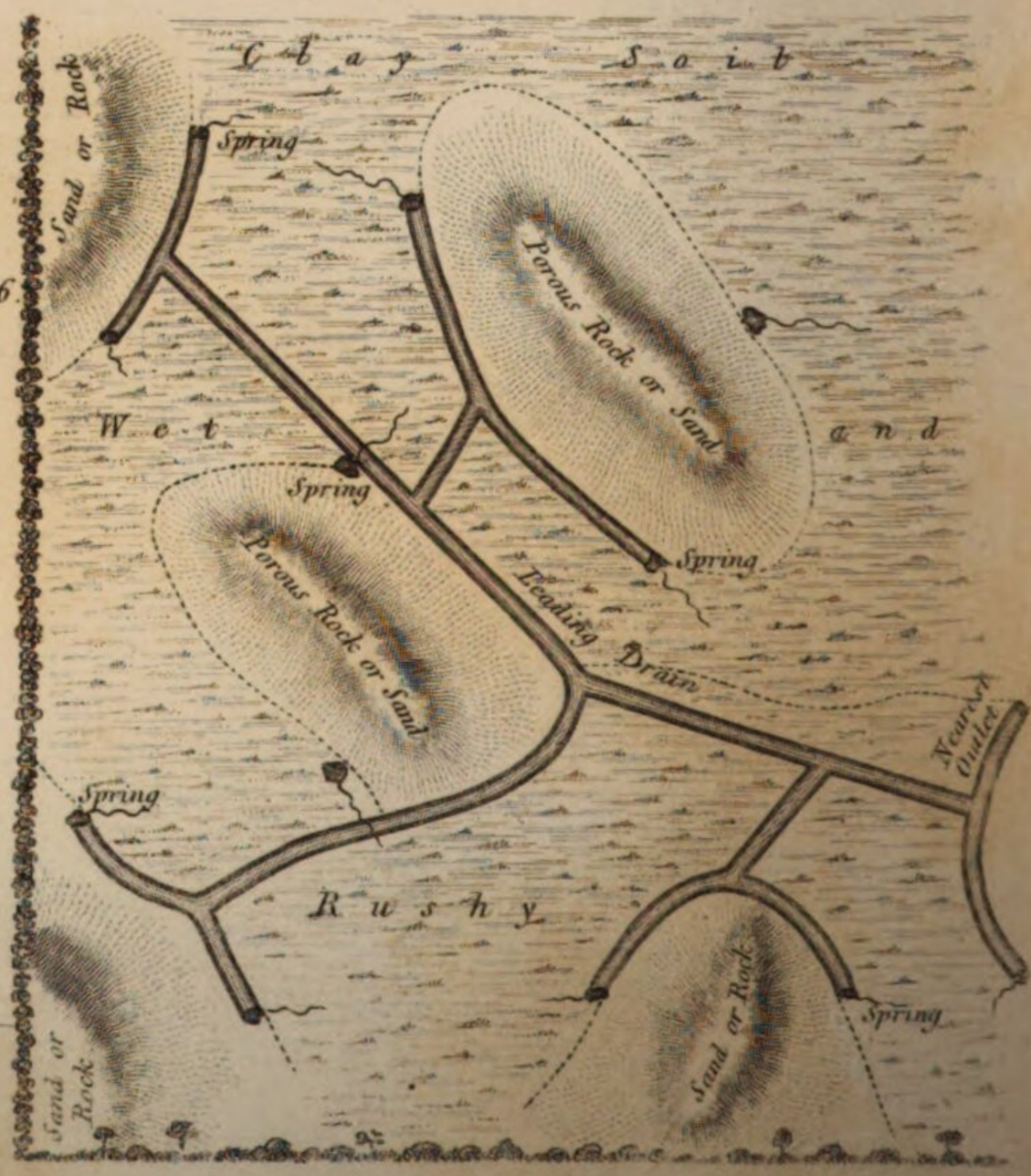


Fig. 6.

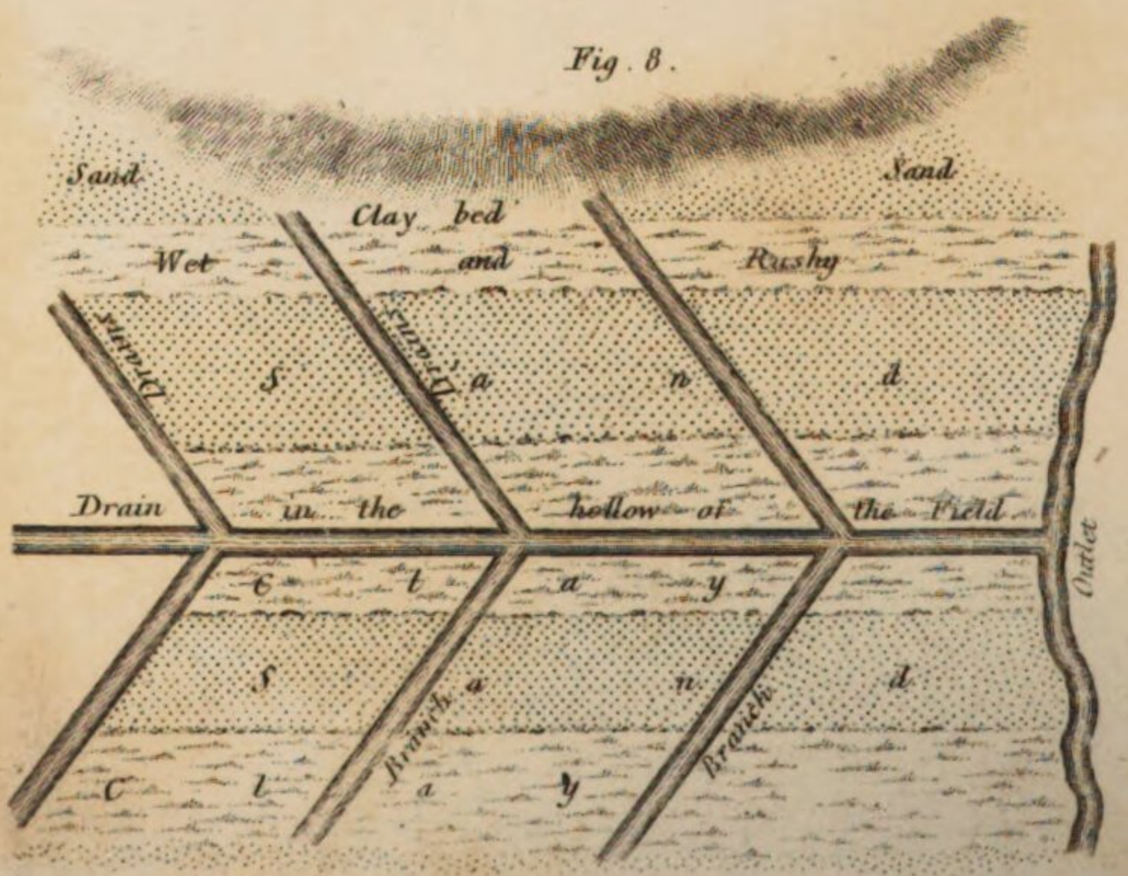


Fig. 8.

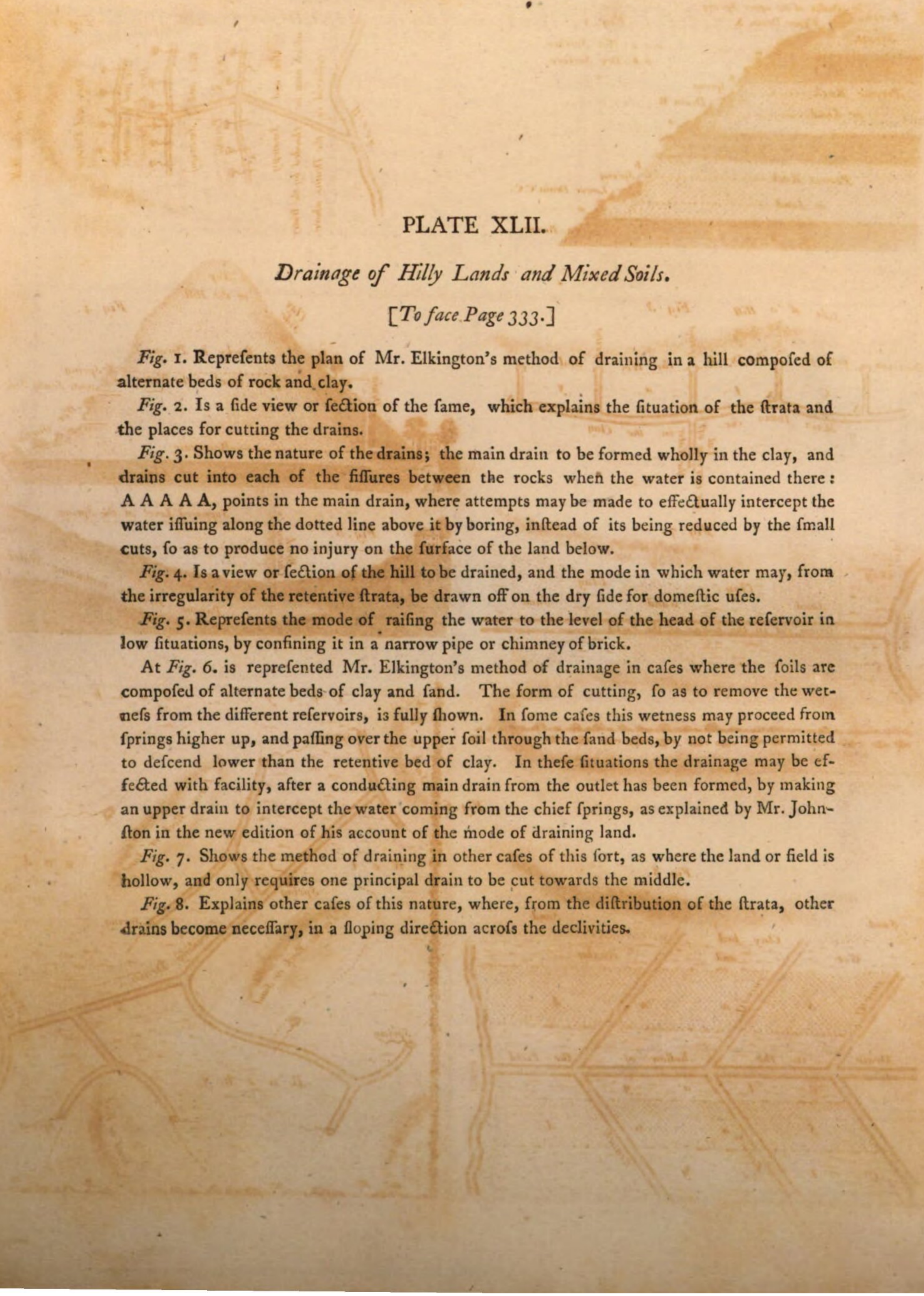


PLATE XLII.

Drainage of Hilly Lands and Mixed Soils.

[*To face Page* 333.]

Fig. 1. Repreſents the plan of Mr. Elkington's method of draining in a hill compoſed of alternate beds of rock and clay.

Fig. 2. Is a ſide view or ſection of the ſame, which explains the ſituation of the ſtrata and the places for cutting the drains.

Fig. 3. Shows the nature of the drains; the main drain to be formed wholly in the clay, and drains cut into each of the fiſſures between the rocks when the water is contained there: A A A A A, points in the main drain, where attempts may be made to effectually intercept the water iſſuing along the dotted line above it by boring, inſtead of its being reduced by the ſmall cuts, ſo as to produce no injury on the ſurface of the land below.

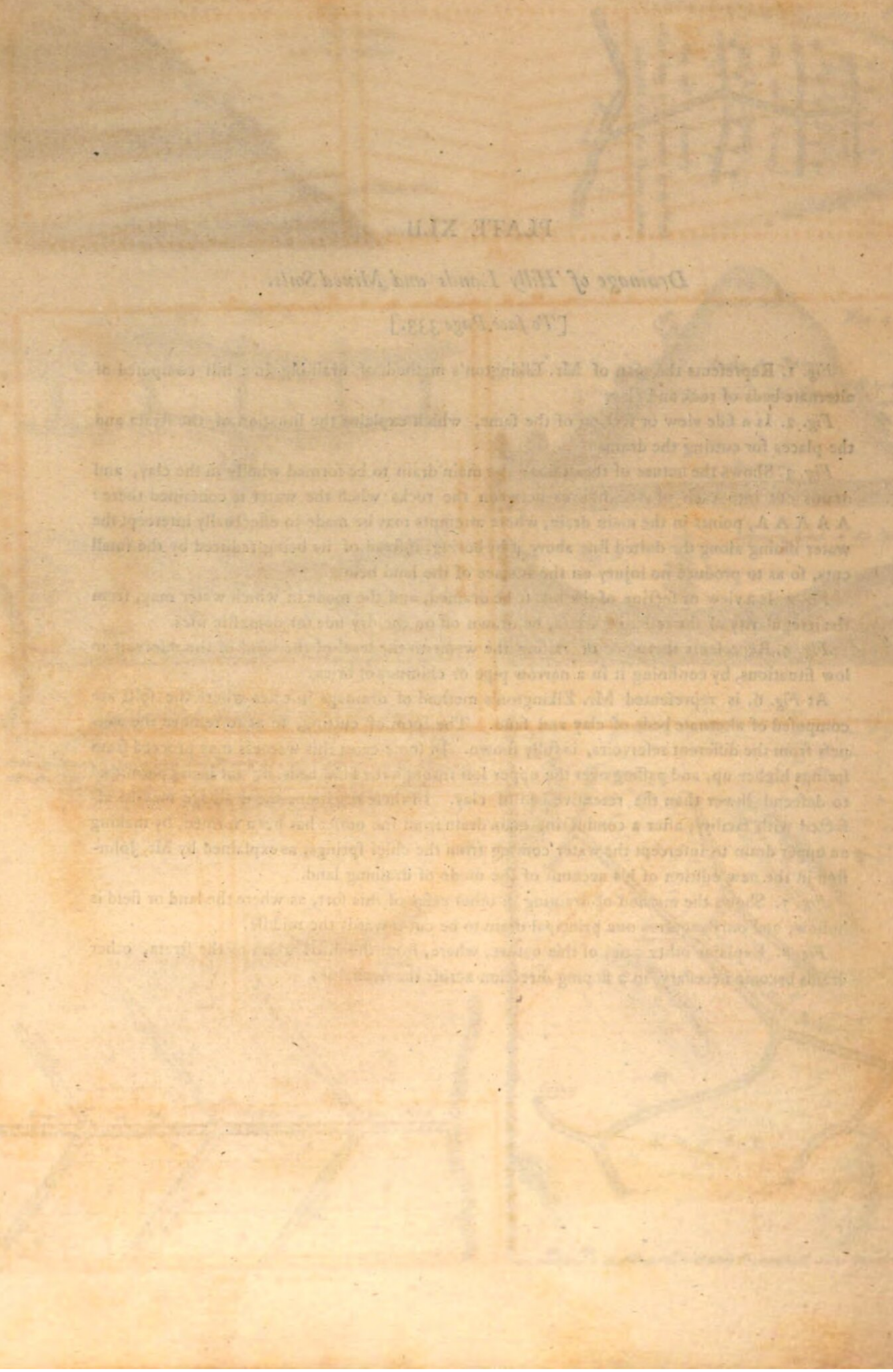
Fig. 4. Is a view or ſection of the hill to be drained, and the mode in which water may, from the irregularity of the retentive ſtrata, be drawn off on the dry ſide for domeſtic uſes.

Fig. 5. Repreſents the mode of raiſing the water to the level of the head of the reſervoir in low ſituations, by confining it in a narrow pipe or chimney of brick.

At *Fig.* 6. is repreſented Mr. Elkington's method of drainage in caſes where the ſoils are compoſed of alternate beds of clay and ſand. The form of cutting, ſo as to remove the wetneſs from the different reſervoirs, is fully ſhown. In ſome caſes this wetness may proceed from ſprings higher up, and paſſing over the upper ſoil through the ſand beds, by not being permitted to deſcend lower than the retentive bed of clay. In theſe ſituations the drainage may be effected with facility, after a conducting main drain from the outlet has been formed, by making an upper drain to intercept the water coming from the chief ſprings, as explained by Mr. Johnſton in the new edition of his account of the mode of draining land.

Fig. 7. Shows the method of draining in other caſes of this ſort, as where the land or field is hollow, and only requires one principal drain to be cut towards the middle.

Fig. 8. Explains other caſes of this nature, where, from the diſtribution of the ſtrata, other drains become neceſſary, in a ſloping direction acroſs the declivities.

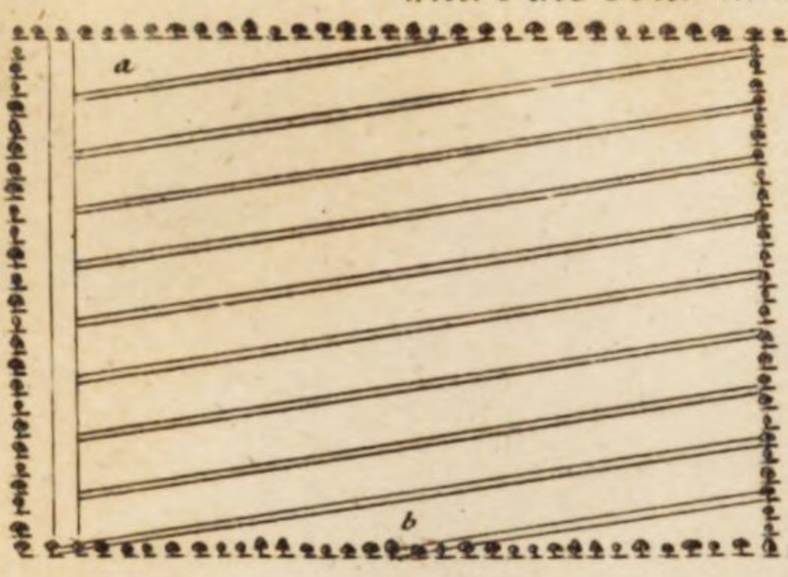


DRAINAGE of LANDS

where the soils are porous above and retentive below.

PL XLIII

Fig.6.



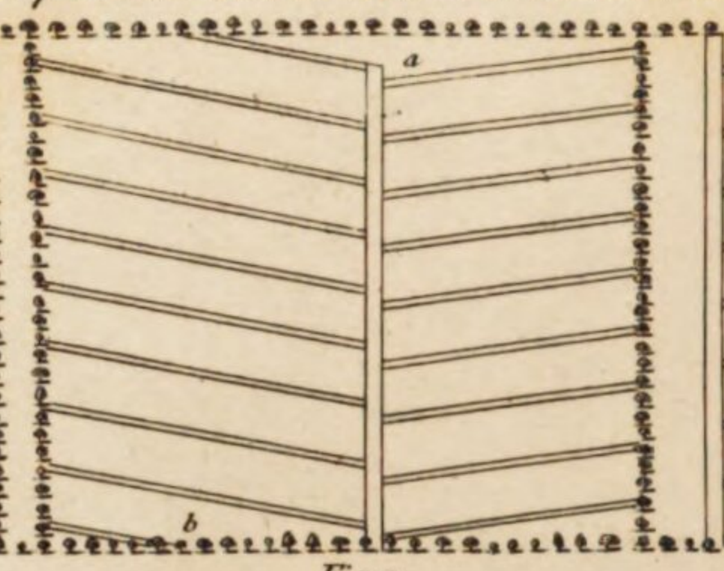


Fig.8.

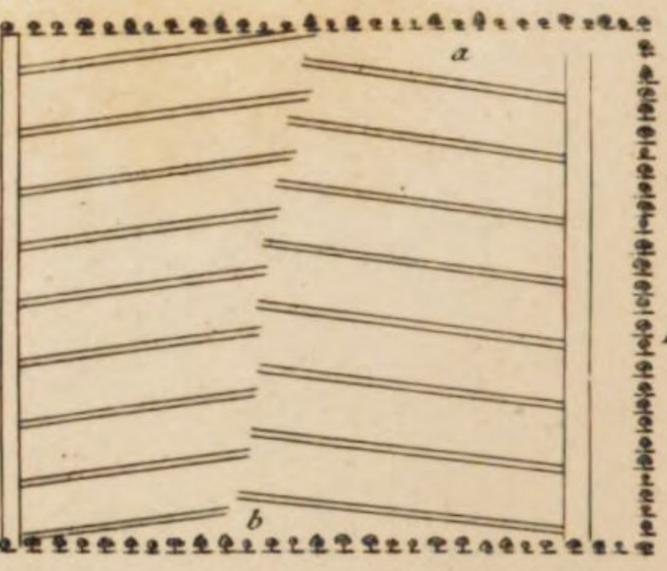


Fig.7.

Fig.1.

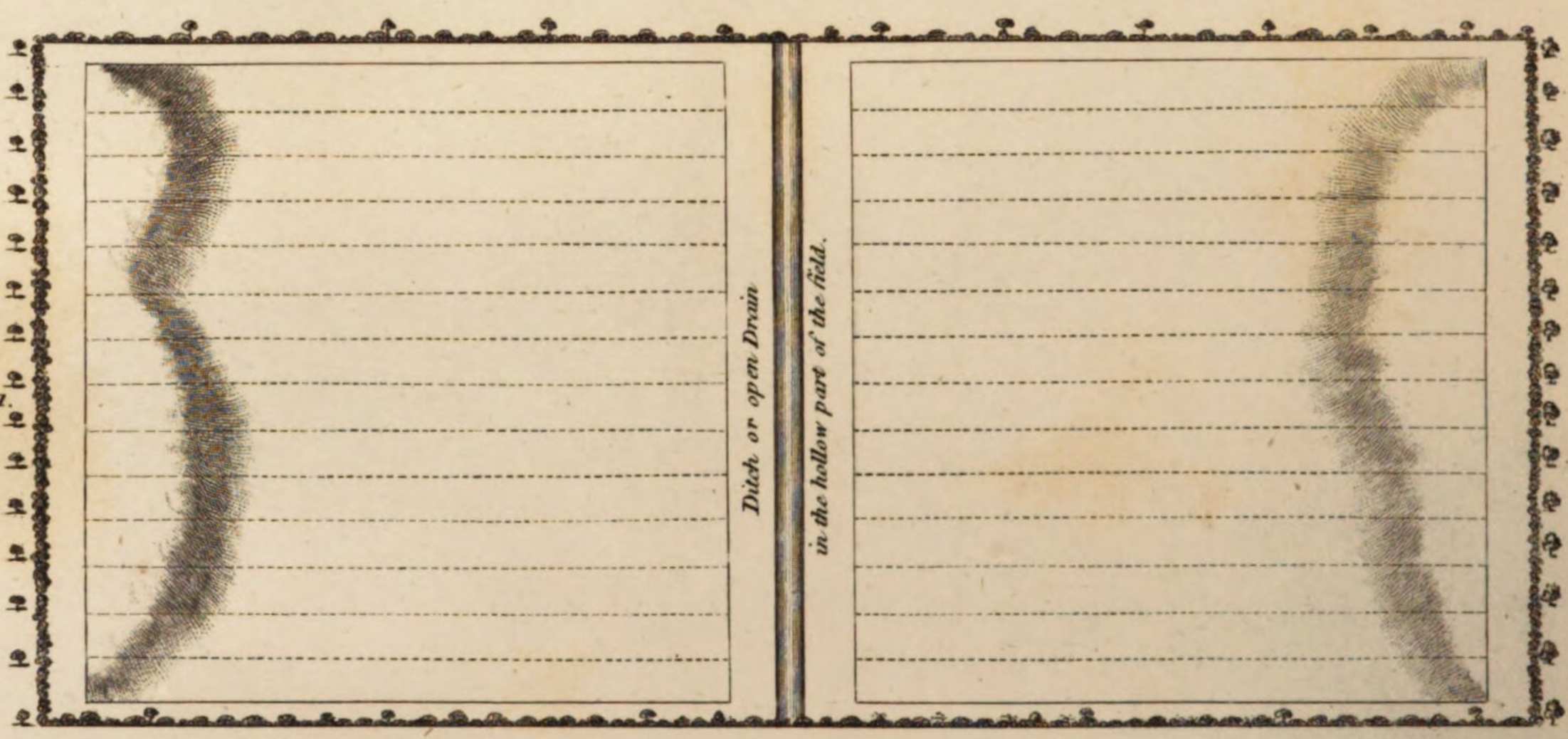


Fig.2.

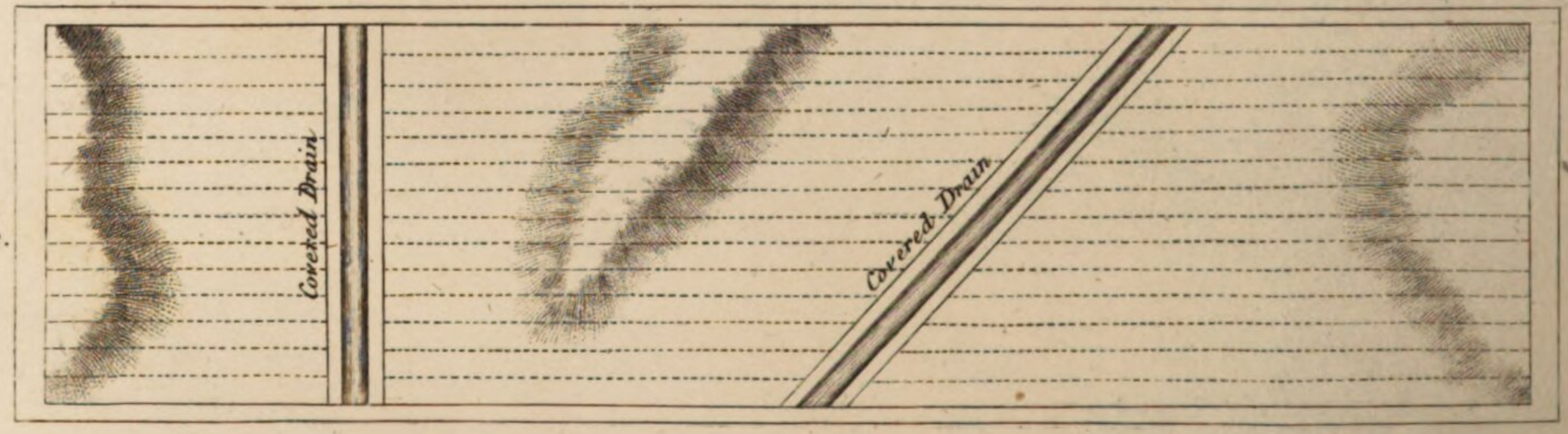
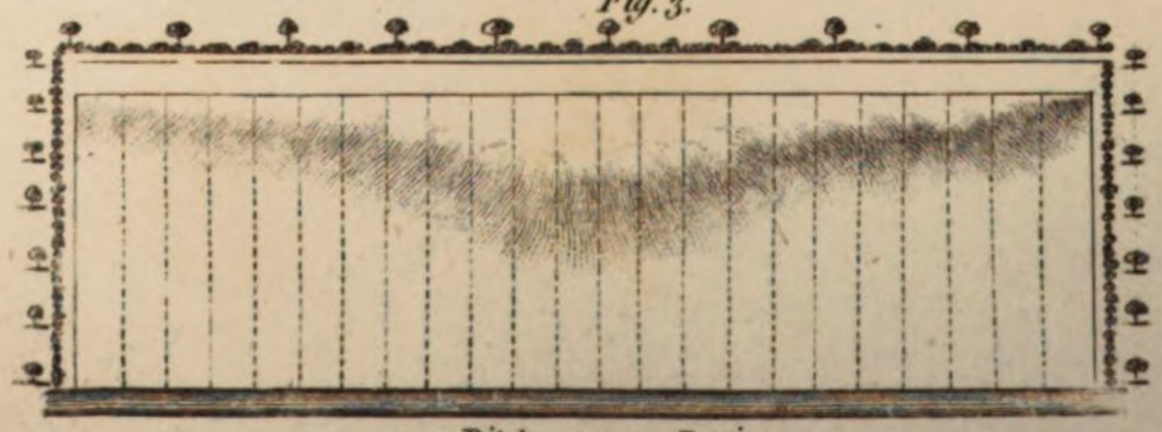


Fig.3.



Ditch or open Drain.

Fig.4.

PLATE XLIII.

Drainage of Lands porous above, and retentive below.

[*To face Page* 332.]

Fig. 1. REPRESENTS the plan of draining followed by Mr. Elkington, where the ſoil is porous on the ſurface and retentive underneath, and where the ground declines towards the midddle where the drain is made, the ridges being formed ſo as to anſwer the declivity.

Figs. 2 *and* 3. Explain the method of forming the drains where the grounds have more than one depreſſion, or are nearly level, or incline a little to one ſide.

Fig. 4. Is a view or ſection of the above.

Fig. 5. The Eſſex method of draining in ploughed ſpringy lands, where the ſurface ſoil is tenacious, as deſcribed by Mr. Kent. Main declination of the land from *a* to *b*.

Fig. 6. Repreſents a field drained by means of one of its ditches in the room of a chief drain.

Fig. 7. A field drained by a principal drain in the middle, declining more at that part than the ſides.

Fig. 8. A field drained by two outſide principal drains, the land being higher in the middle than on the ſides.

PLATE XLIII.

[To face Page 332.]

Fig. 1. Represents the plan of draining followed by Mr. Elkington, where the soil is pervious on the surface and retentive underneath, and where the ground declines towards the middle where the drain is made, the ridge being formed so as to subvert the declivity.

Figs. 2 and 3. Explain the method of forming the drains where the grounds have more than one depression, or are nearly level, or inclining a little to one side.

Fig. 4. Is a view or section of the above.

Fig. 5. The Eller method of draining in ploughed (pressy lands, where the furface foil is tenacious, as described by Mr. Kent. Main declination of the land from a to b.

Fig. 6. Represents a field drained by means of one of its ditches in the room of a thief drain.

Fig. 7. A field drained by a principal drain in the middle, declining more at that part than the sides.

Fig. 8. A field drained by two outside principal drains, the land being higher in the middle than on the sides.

DRAINAGE IN VARIOUS KINDS OF SOIL.

Fig. 1.

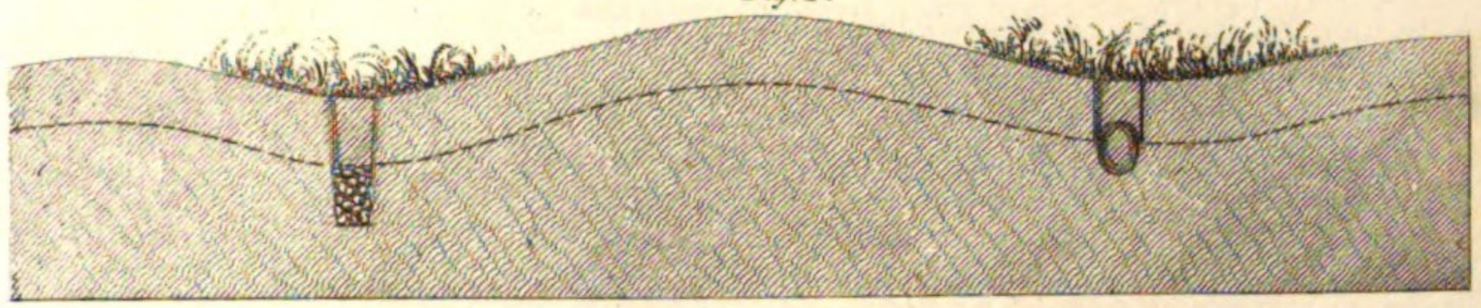


Fig. 4.

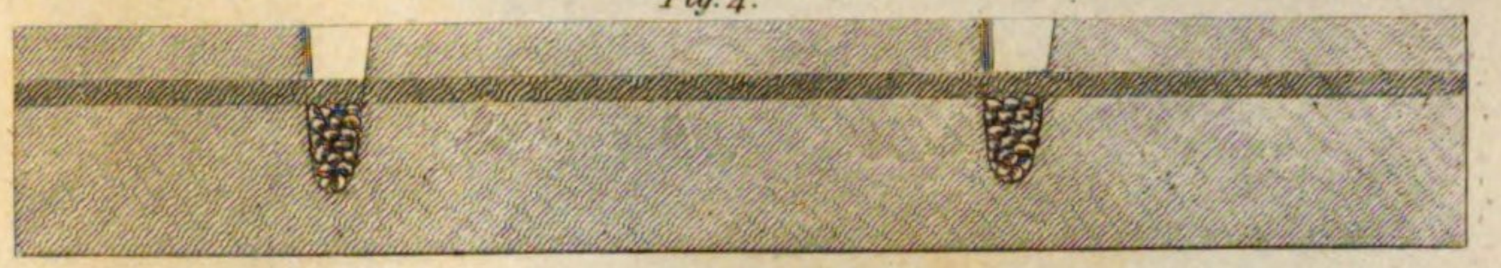


Fig. 2.

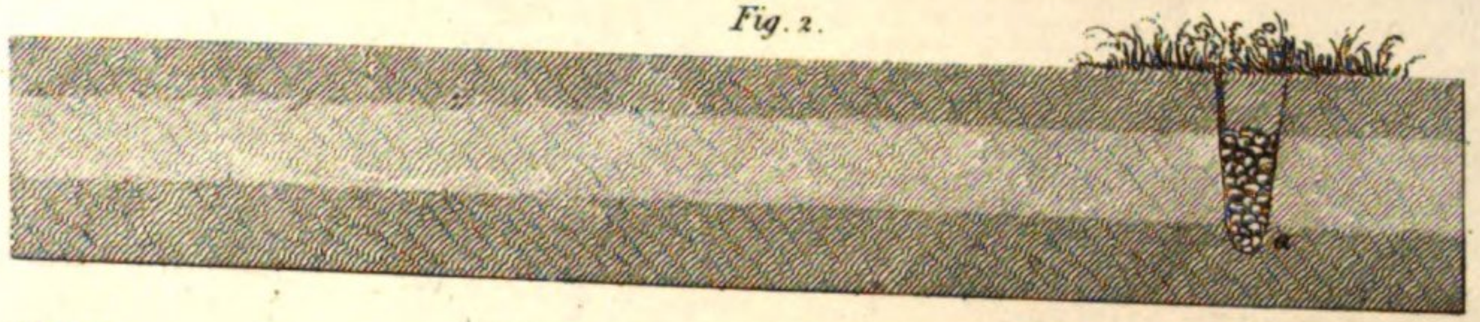
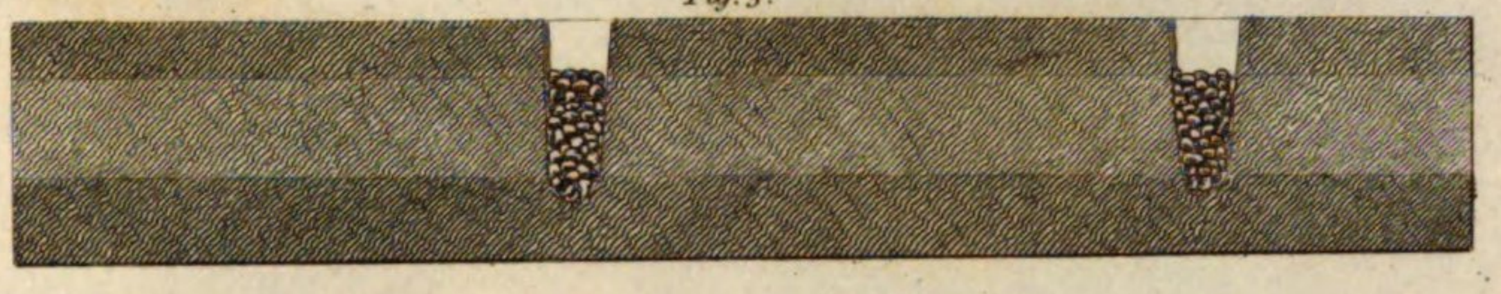


Fig. 3.



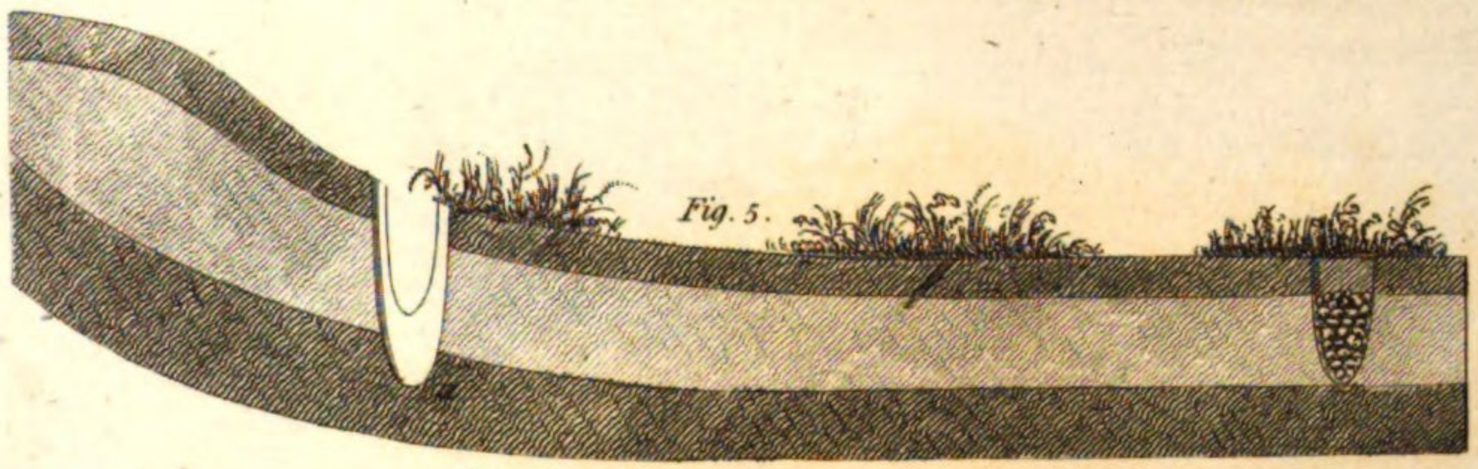


Fig. 5.

Fig. 6.

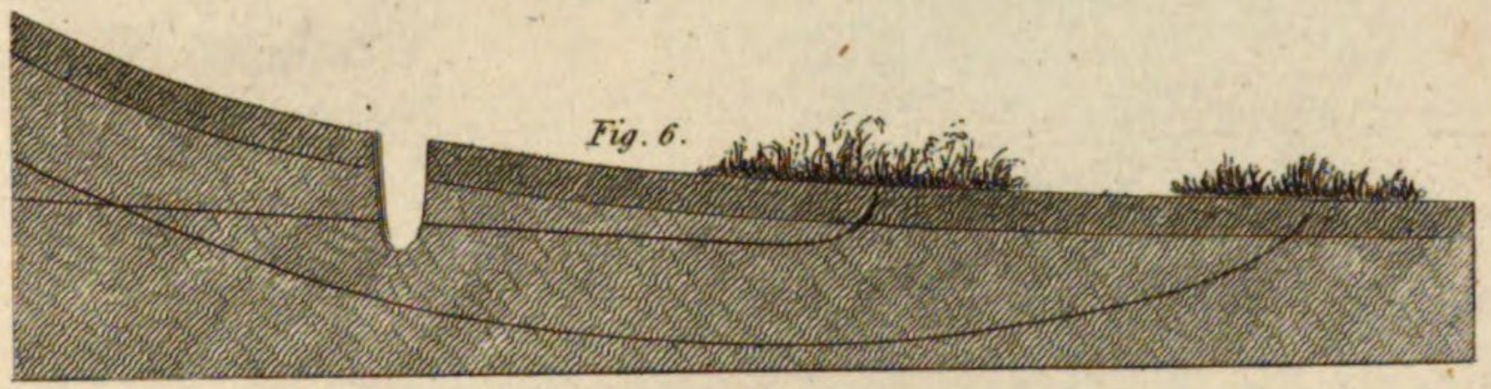


Fig. 8.

Fig. 7.

Fig. 9.

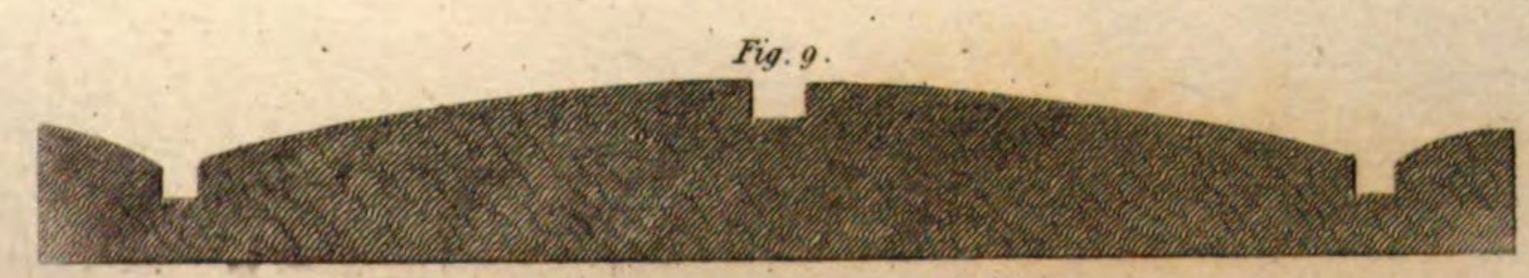


Fig. 10.

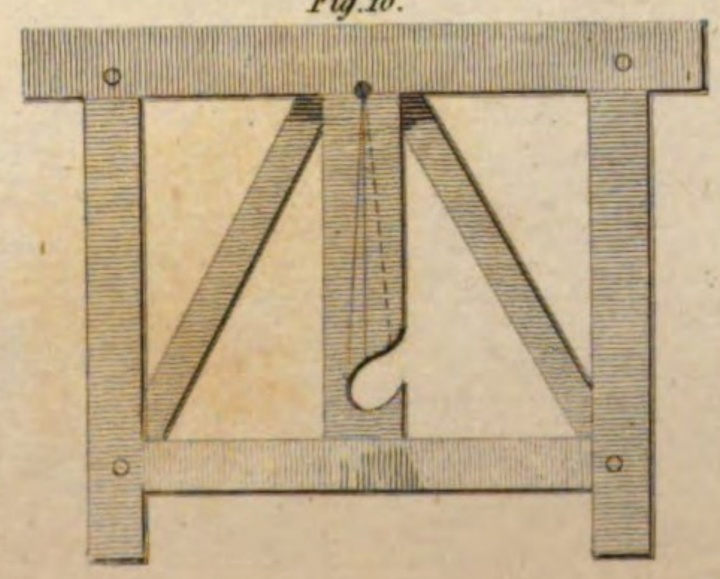


Fig. 11.

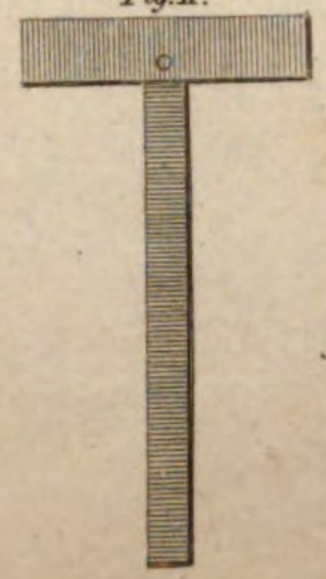


PLATE XLIV.

Drainage in various Kinds of Soil.

[*To face Page* 332.]

Fig. 1. Repreſents a mode of draining where the ſurface, ſubſoil and baſe of the ſoil are impervious, and where the ridges are improper to be levelled down by ſubdrains in the furrows between them.

Fig. 2. Shows a manner of draining where the ſurface ſoil and baſe are repellent, and the ſubſoil porous or abſorbent, by ſidelong drains where the land has much declivity, formed in the parts where the wetneſs is predominant, as at *a*, down to the under ſtratum and a little into it.

Fig. 3. Exhibits a method of draining where the ſurface is impervious, the ſubſoil abſorbent and cloſed, and the baſe impervious or abſorbent and cloſed, by drains formed according to circumſtances in a ſimilar manner to thoſe in *Fig.* 2. In this caſe they will ſeldom be required to be ſo near to each other as in the former caſe.

Fig. 4. Explains a mode of draining where the ſurface and ſubſoil are abſorbent and cloſed, and the baſe either impervious or abſorbent and cloſed, by cutting drains through the ſubſtrata, forming a firm baſe for the bottoms of them when neceſſary with tough turf, heath or buſhes, performing the work in a dry ſeaſon.

Fig. 5. Repreſents a mode of draining where the ſurface ſoil is impervious or abſorbent, the ſubſoil porous and cloſed, being conſtantly charged with wetneſs from internal deſcending water by means of a gravelly conductor, the baſe being impervious by the cutting of only one drain acroſs, at the lower part of the ſlope, as at *a*, where the ſubſoil is ſufficiently porous.

Fig. 6. Explains a method of draining where the ſurface ſoil is porous or impervious, the ſubſoil abſorbent or varied, being charged with water from above in a partial manner, through veins, or ſand, gravel, or fiſſured rock, by means of covered drains made to decline in an eaſy manner, from the affected part to a common drain.

Theſe modes are recommended by Mr. Marſhall.

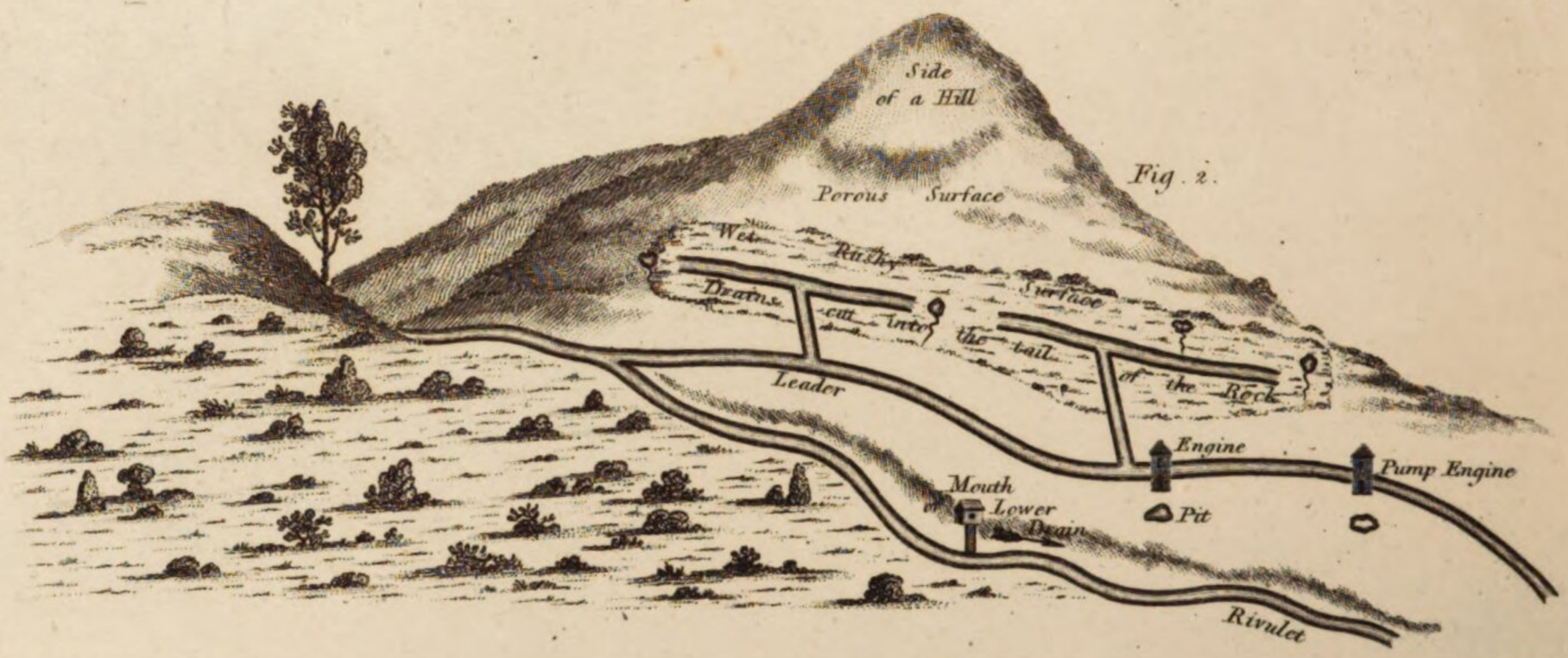
Fig. 7. Is a tranſverſe ſection of a ridge on a flat ſurface for watering in the firſt year of its formation, uſed in Glouceſterſhire.

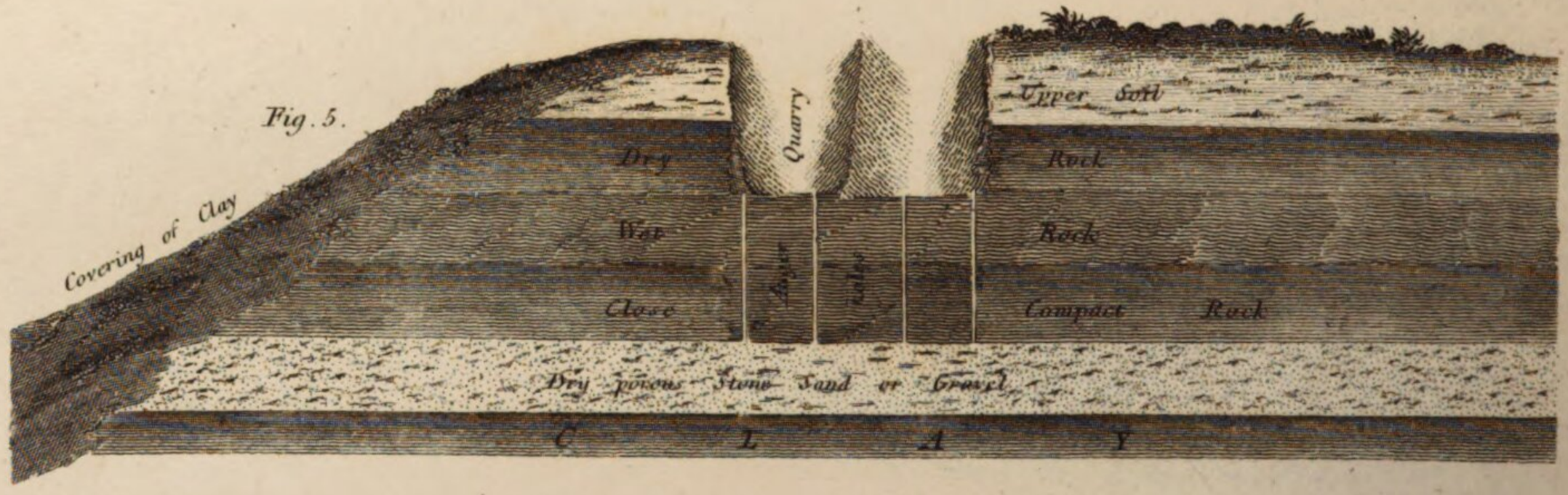
Fig. 8. Shows a ridge in its full elevation with its ſides being perfectly inclined planes, having the proper fall of two inches in each yard.

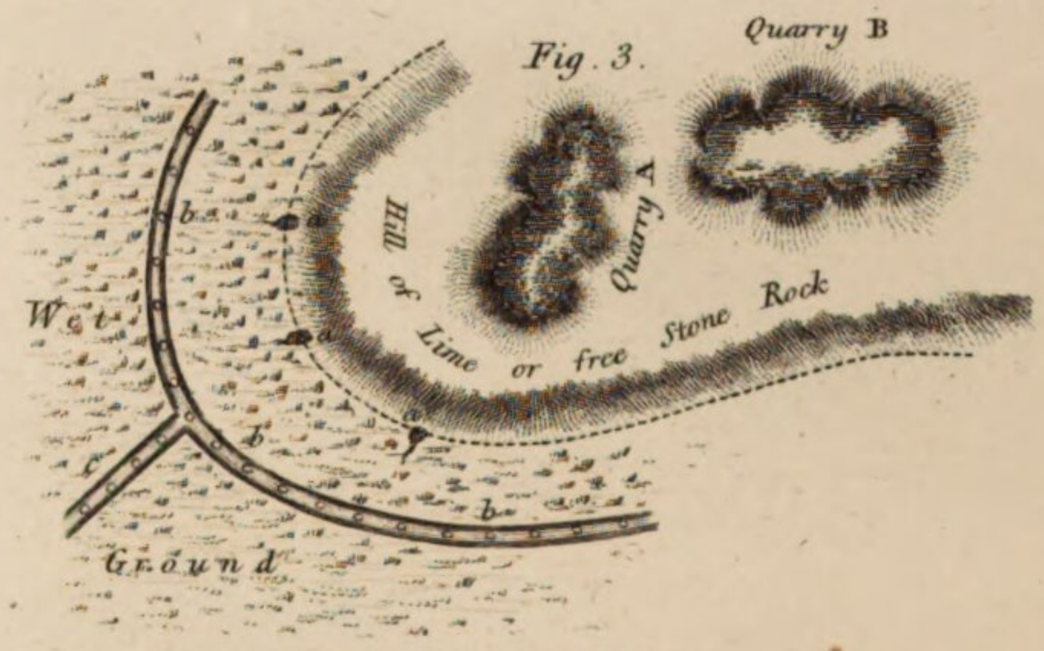
Fig. 9. Explains the form of a ridge for trying the effects of watering in flat land.

Fig. 10. Is a levelling implement recommended by Mr. Marſhall, as very uſeful in ſetting out water-courſes, ſo as to give every part an equal and uniform degree of deſcent. It ſhould be made five feet and a half long, and in height from four to four feet and a half, according to the height of the perſon to employ it.

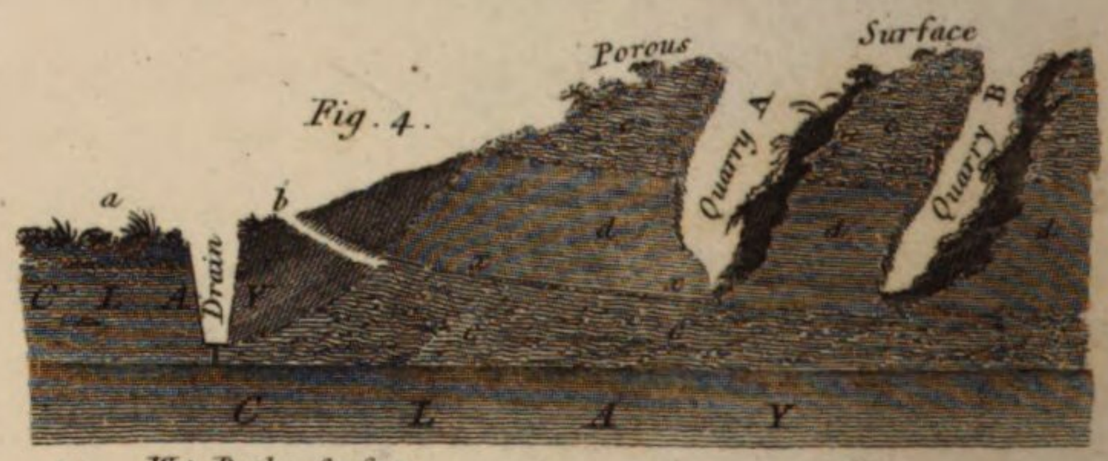
Fig. 11. Is the object ſtaff: the croſs piece ſhould be painted white. The whole ſhould be made of a good ſize, and exactly as high as the level.







a.a.a. Springs or Outlets of part of the Water.
b.b.b. Drain along the tail of the Rock.
c. Drain for carrying off the Water.



a. Wet Rushy Surface.
b. Outlet of the Water.
c.c. Upper Soil.
d.d.d. Dry Rock.
e.e. Wet Rock.
x.x. Upper Level of the Water.

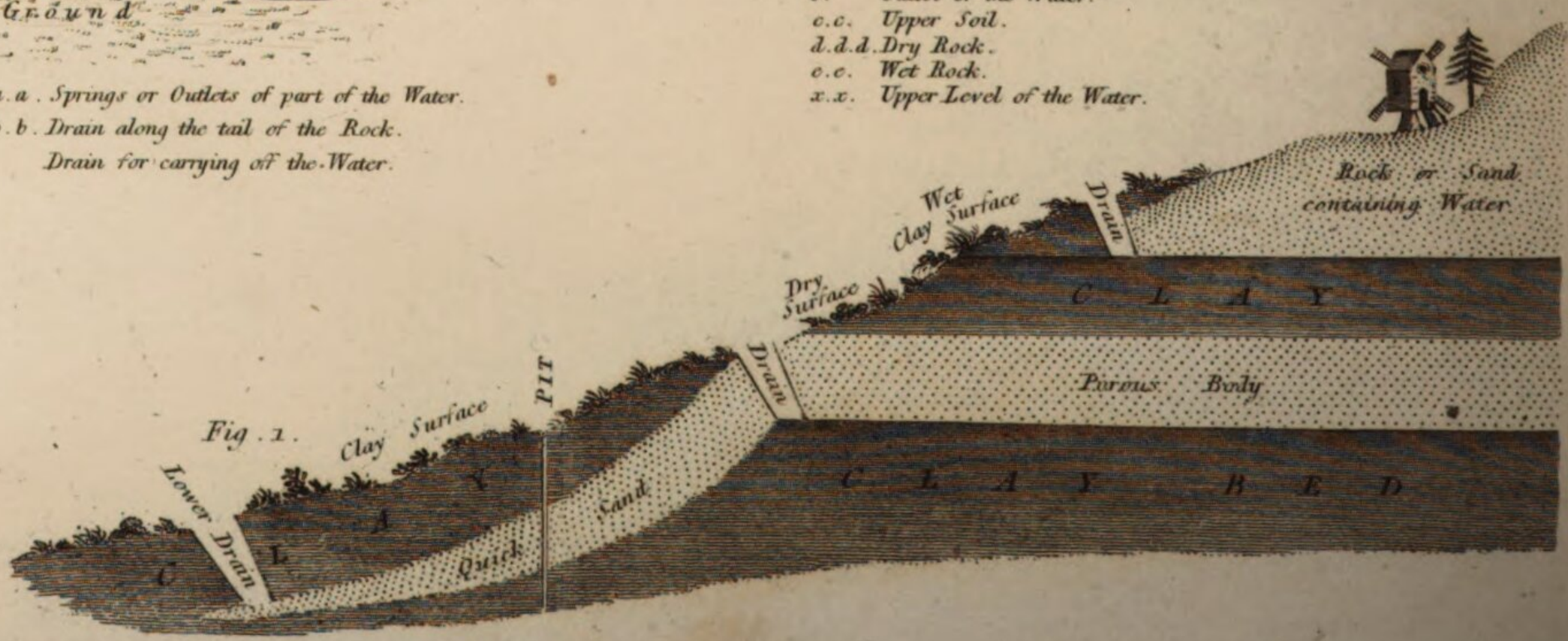


PLATE XLV.

Drainage of Mines, Quarries, &c.

[*To face Page* 333.]

Fig. **1.** Repreſents a view or ſection of the drainage of a mine, as practiſed by Mr. Elkington, explaining the manner of cutting off the water in ſinking the ſhaft, &c.

Fig. **2.** Is the plan and manner of forming the drainage.

Fig. 3. Explains the mode of cutting the drains through the clayey ſtratum covering the rocks, ſo as to diſcharge the water there pent up by it.

Fig. 4. Is a view or ſection of this drainage.

Fig. 5. Repreſents the method of letting the water down into the porous ſtratum below, by digging pits or boring through the impervious body by an auger. In ſome caſes another porous ſtratum may be diſcovered by boring below the ſecond retentive one, and the water be thereby reduced to a ſtill lower level.

DRAINAGE OF WETNESS, CAUSED BY MINERAL STRATA.

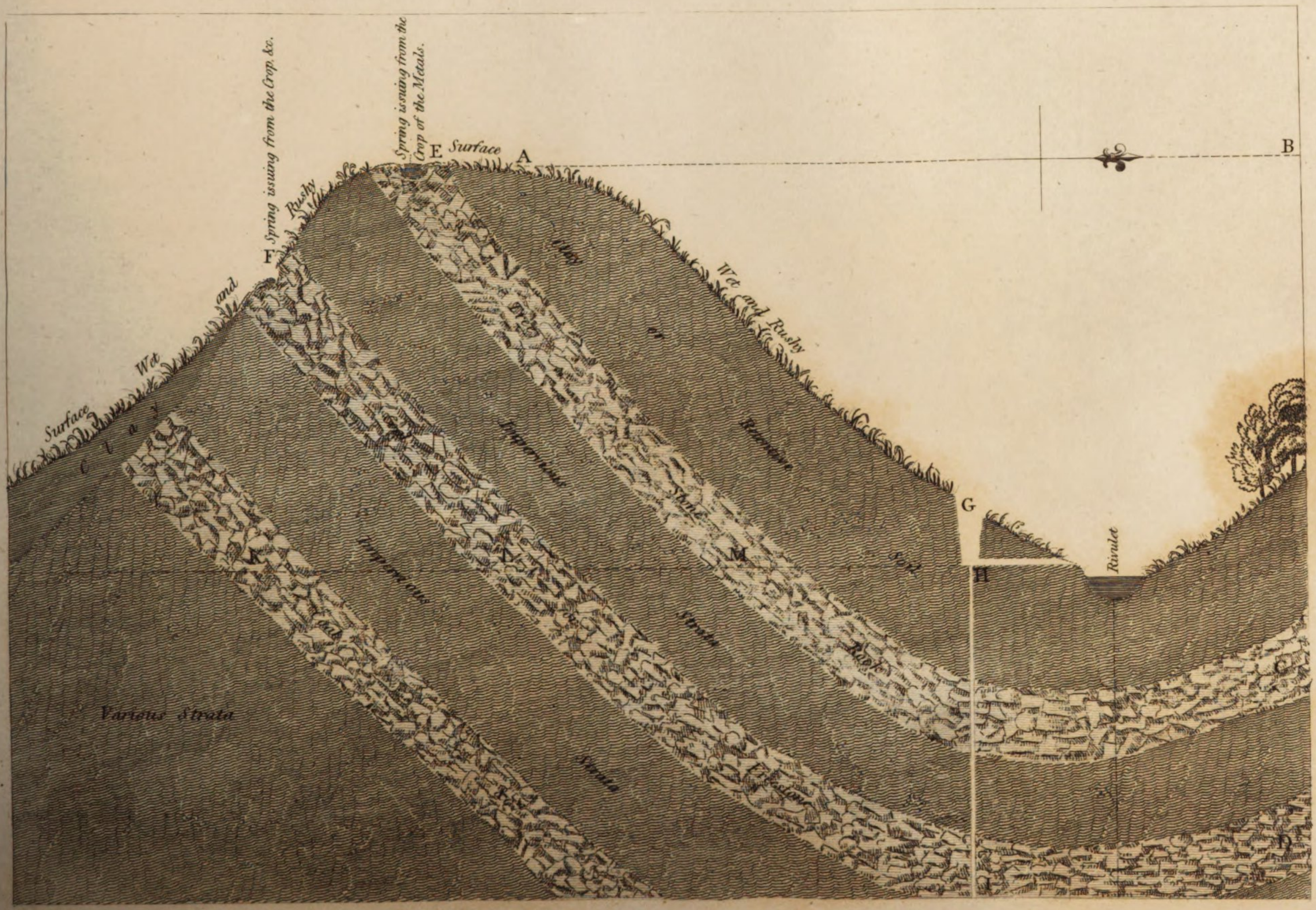
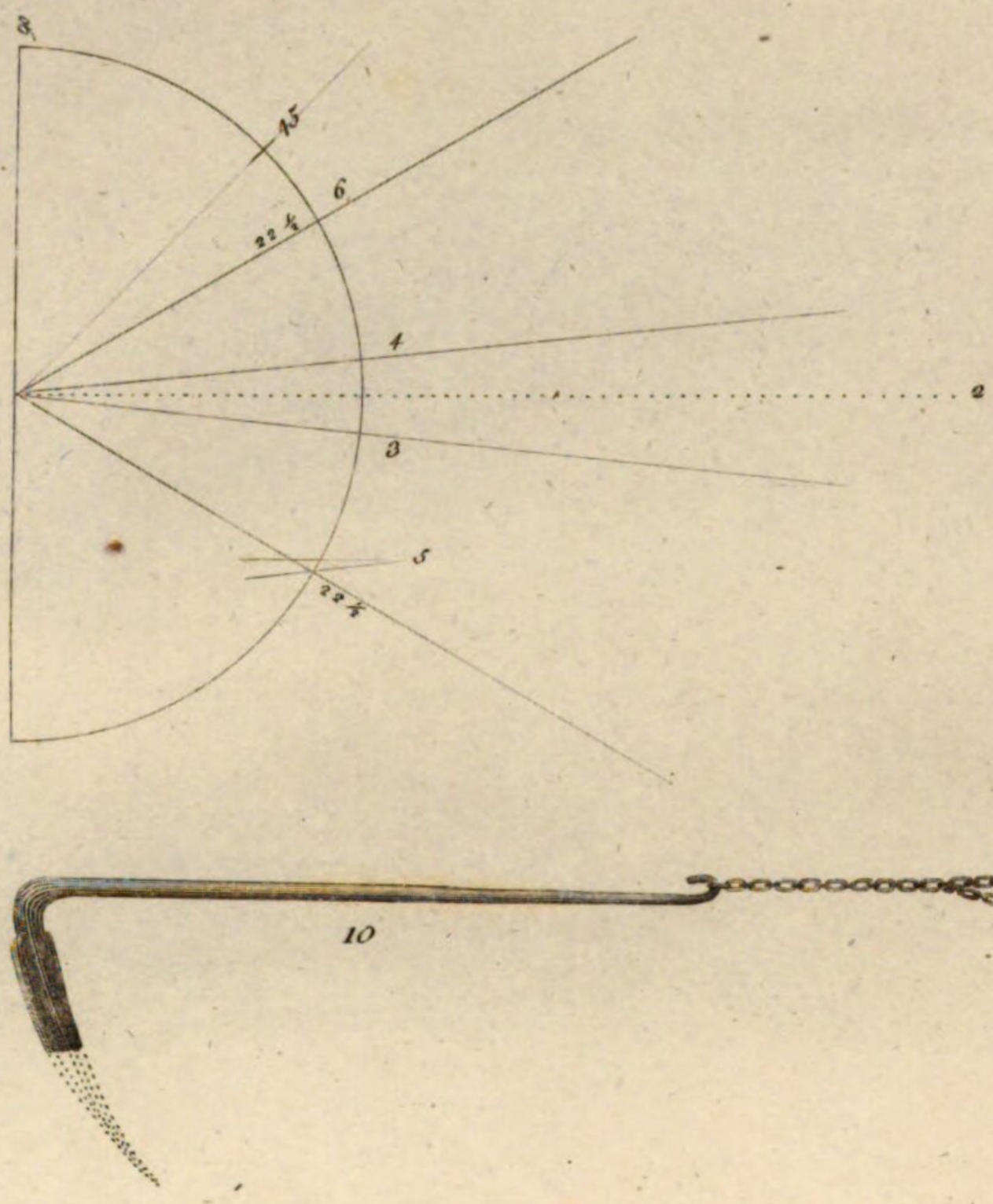


PLATE XLVI.

Drainage of Wetneſs cauſed by Mineral Strata.

[*To face Page* 332.]

Fig. 1. Shows the plan of draining wetneſſes on the tops of hills and banks, contiguous to low grounds, but ſupplied from high lands at ſome diſtance by means of metallic ſubſtrata. The ſtrata C D continue on ſome riſe in high ground north of rivulet to higher level than line A B, by which ſprings, E and F, from the *crop* of the metals, are ſupplied. An outlet will be obtained by a cut from a rivulet to bank G free of the former, and by boring or ſinking: pit from H to I the water paſſing through porous ſtrata from C D to E F will be reduced to the level L M; of courſe, the ſource of ſprings E F be cut off, and ground on top and ſides of hill become dry; and metals to that depth wrought without inconvenience from water, which could not be done by boring in bottom of rivulet, as ſhown by dotted line. When ſtrata K crop out to ſurface and produce wetneſs, the pit or bore H I may be continued till it reach it when neceſſary. This is a method deſcribed by Mr. Johnſtone, in his account of Mr. Elkington's mode of draining.


8
15
6
22½
4
2
3
5
22½

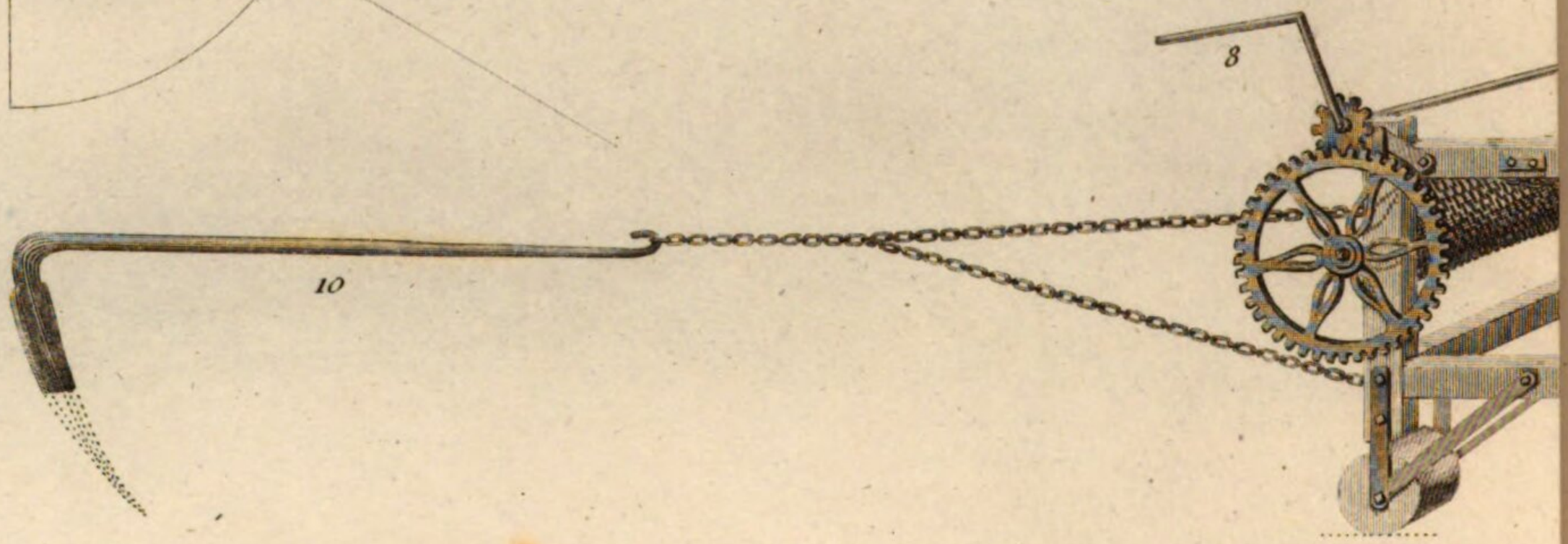

8
10

PLATE XLVII.

Mr. Lumbert's Mole-Plough.

[*To face Page* 332.]

In the Plate are given repreſentations of the plough, and the windlaſſes by which it is drawn: in which *Fig.* 1. is the beam. 2. the mole, to which ſegments for lengthening it ſcrew on at 3. 4. the roller at the heel on which it preſſes. 5. the chain, from 50 to 60 yards long, which winds on to the two cylinders, 7, 7. 6, a pulley, round which the chain 5. plays. 8, 8, 8, 8. Windlaſſes, turned each by two women. 9. Stays which, entering the ground, aſſiſt in keeping the machine ſteady. 10. the anchor.

The proportion and reſpective angles of the different parts of the implement may be found by the ſcale. It is wrought by eight women; and Mr. Lumbert contracts for the work at $1\frac{1}{2}d.$ the perch, lug, or rod of $5\frac{1}{2}$ yards, his foreman agreeing with him for doing it at three farthings, the machine being found, who pays himſelf and the women out of it. It performs from 150 to 200 perches a day; and 300 have been done. 200, at three farthings the perch, amounts to 12*s.* 6*d.* a day; the eight women, at 8*d.* each, amounts to 5*s.* 4*d.*, leaving 7*s.* 2*d.* for the foreman's pay, and the repairing of the chain, which breaks often, and wants a falſe link whenever that happens. It was found to move, on an average, 5 yards in a minute; but much time is taken up by moving the windlaſs, frame, and anchor.

The inventor goes to any part of the kingdom with the machine, at $1\frac{1}{2}d.$ the rod; but when to a diſtance, muſt have inſured work in the proportion of 200 rods for every mile out. He ſells the tool for 50 guineas, as he has a patent. It uſually goes 17 or 18 inches deep, but can go deeper; and has been found a very effective tool on clayey ſoils, the drains continuing to run after many years.

Mr. Young has given a particular account of this valuable draining-plough, and ſuggeſted various applications of the windlaſſes, which may be ſeen in the forty-ſecond volume of the Annals of Agriculture, page 413.

SECTIONS of covered DRAINS, & draining Implements.

PL. XLVIII

Fig. 1

Fig. 2

Fig. 3

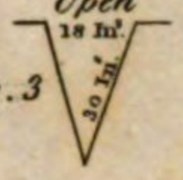


Fig. 4

Fig. 5

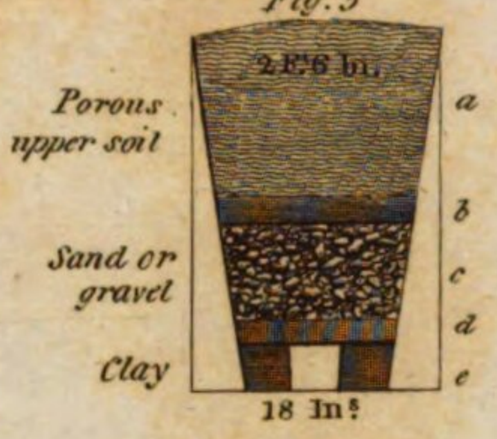


Fig. 6

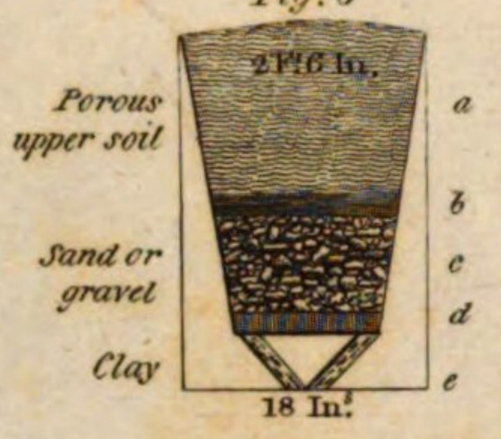


Fig. 7

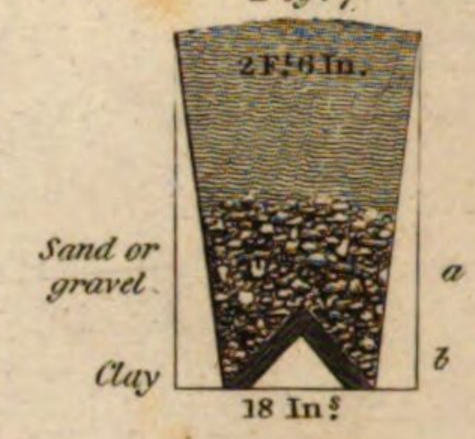


Fig. 8

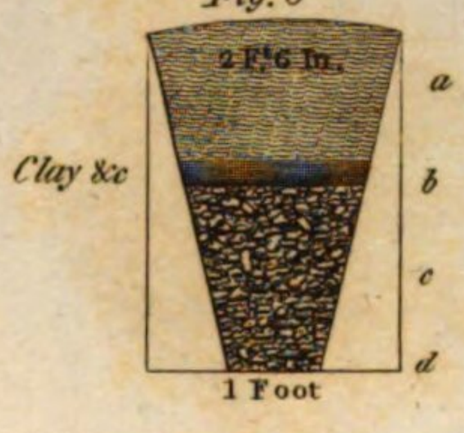


Fig. 9

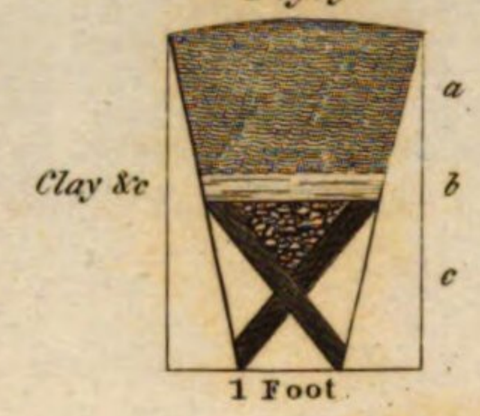


Fig. 10

Fig. 11

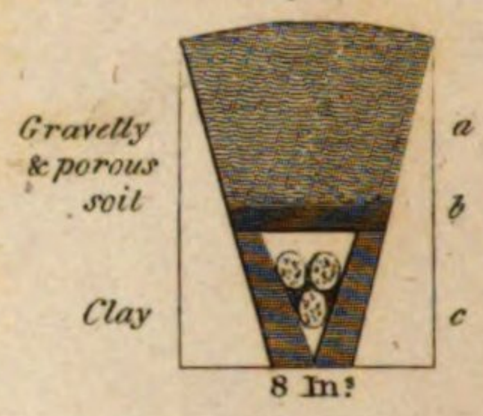


Fig. 12.

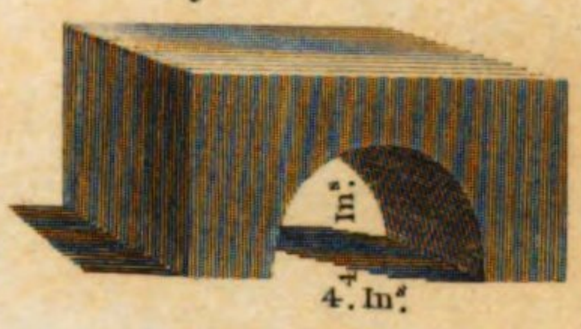


Fig. 13.

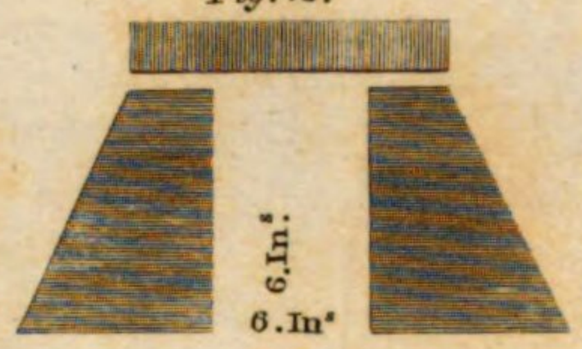


Fig. 14.

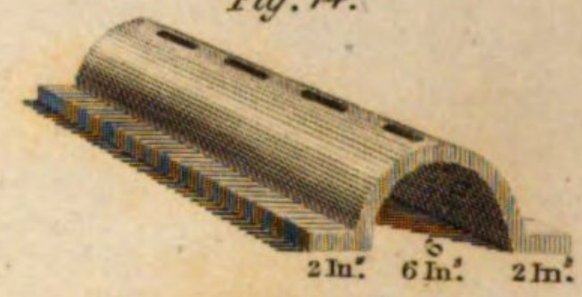


Fig. 15

Fig. 17

Fig. 16

Fig. 18

Fig. 19.

Engine for twisting Straw into ropes for laying in the bottoms of Drains.

Fig. 28.

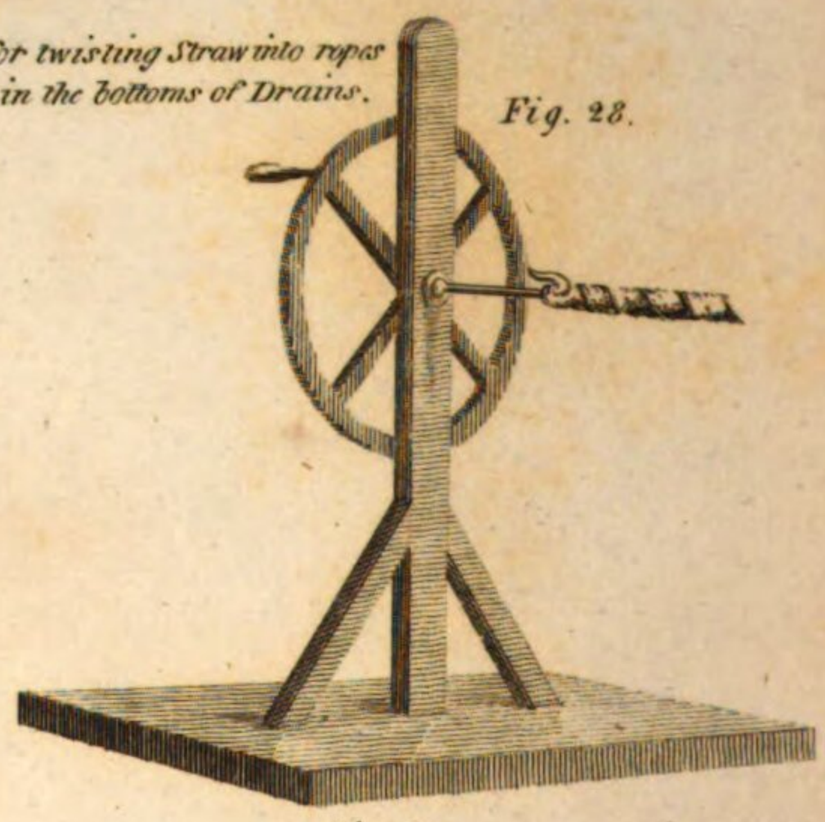


Fig. 26

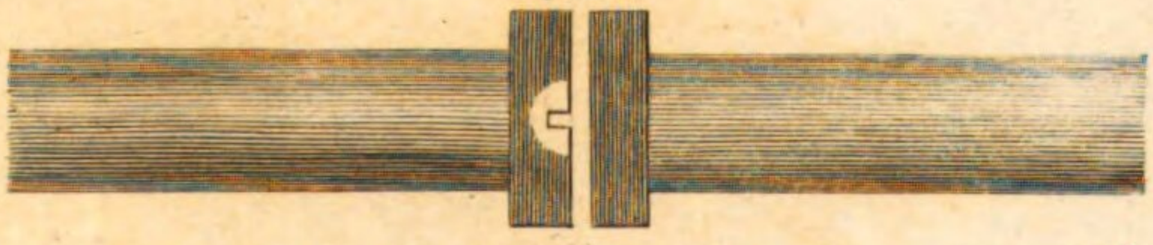


Fig. 20

Fig. 25

Fig. 27

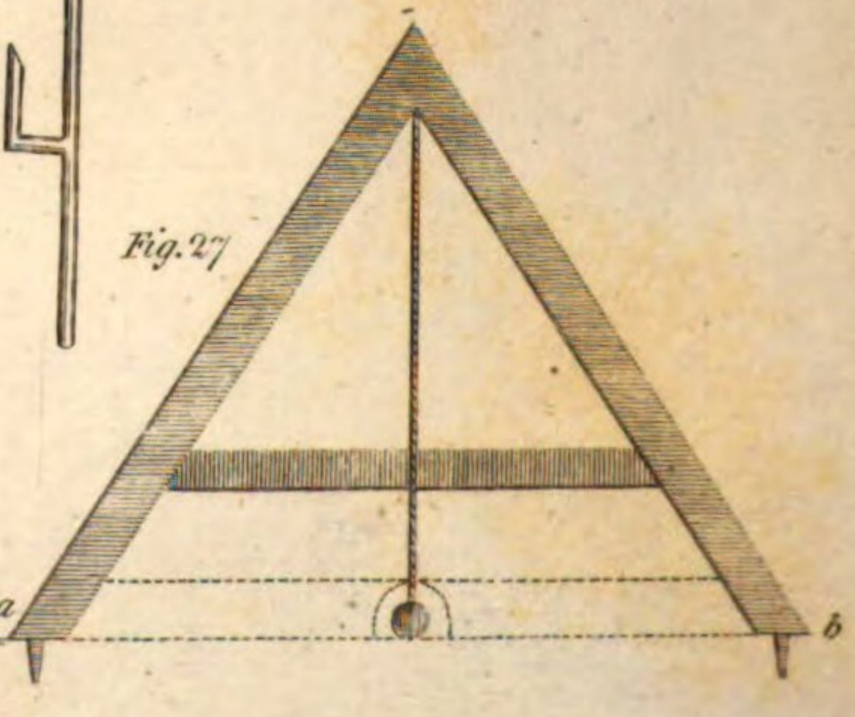


Fig. 21

Fig. 23

Fig. 22

Fig 24

PLATE XLVIII.

Sections of Covered Drains and Draining Implements.

[*To face Page* 332.]

Fig. 1. Repreſents a *ſhouldered turf-drain*; the inverted turf reſting here more firmly on the ſhoulders than in the common method without them, leaving the part hollow below.

Fig. 2. Shows it filled up.

Fig. 3. Repreſents the *wedge-form* of drain, a part of the bottom of the wedge part being removed before it is put in again.

Fig. 4. Shows it when filled up.

Fig. 5. The ſection of a hollow drain: *a* looſe mould thrown in to the depth of one foot; *b* ſod inverted two inches thick; *c* round land ſtones one foot thick; *d* flat ſtone or cover four inches thick; *e* ſough or conduit ſix inches ſquare lined with ſtone.

Fig. 6. Another ſection: *a* looſe mould as above; *b* thin ſod inverted, ſtraw, heath or ruſhes; *c* round land ſtones or faggots of bruſh-wood; *d* flat ſtone or cover four inches thick; *e* triangular opening ſix or eight inches.

Fig. 7. A ſection of drain: *a* land ſtones as before; *b* triangular or coupled opening, ſix or eight inches.

Fig. 8. Section of hollow drain: *a* looſe mould or gravel thrown in one foot; *b* ſod, ſtraw, heath, or ruſhes, four inches; *c* land ſtones thrown in; *d* one foot eight inches thick.

Fig. 9. Section of covered drain: *a* looſe mould thrown in one foot; *b* ſtraw, &c., ſix inches in thickneſs; *c* bruſhwood laid longitudinally and ſuſpended by croſs billets of wood, having bottom and ſides to the height of croſs billets open one foot ſix inches.

Fig. 10. Another ſection of hollow drain: *a* looſe mould or gravel one foot; *b* ſod inverted ſix inches; *c* pipe or opening formed by draining-ſpade, one foot deep and eight wide at ſhoulders.

Fig. 11. Section of covered drain: *a* drain one foot deep; *b* clay trampled in ſix inches; *c* pipe or opening formed by draining-ſpade one foot deep, and filled with three large ſtraw ropes, laid lengthways.

Fig. 12. Repreſents a *draining-brick* chiefly uſed for ſmall drains, as conveying water to houſes, and

Fig. 13. Shows another ſort of *draining-brick* for conſtructing a large ſquare drain laid without common brick.

Fig. 14. Exhibits another form of *draining-brick* for forming larger ſorts of drains.

Fig. 15. Upper draining-ſpade.

Fig. 16. Lower draining-ſpade pointed at the bottom.

Fig. 17. Wooden ſpade for peaty ſoils.

Fig. 18. Bottom ſhovel with turned-up edges.

Fig. 19. Scoop for cleaning out and ſmoothing out bottom of drains.

Fig. 20. The rod ſcrew for the auger four feet.

Fig. 21. Chiſel and punch for cutting ſtones.

Fig. 22. The auger.

Fig. 23. Wooden handle with iron plates on both ſides to ſtrengthen holes for rods; *a a* wedges.

Fig. 24. Iron key.

Fig. 25. Iron handle.

Fig. 26. Boards uſed in boring with the auger.

Fig. 27. An inſtrument for levelling drains, water-courſes, &c.: *a b* the ſides of the frame; *a d* a line marked off.

Fig. 28. Is an improved machine for twiſting ſtraw into ropes.

DRAINING BRICKS.

Fig. 1.

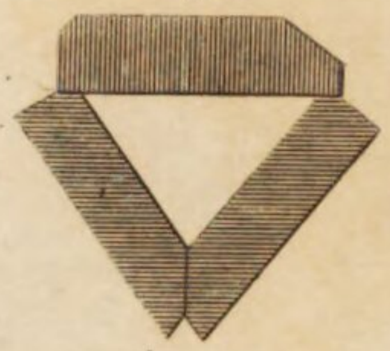


Fig. 2.

Fig. 3.

Fig. 4.

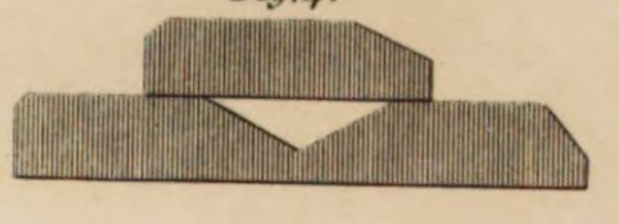


Fig. 5.

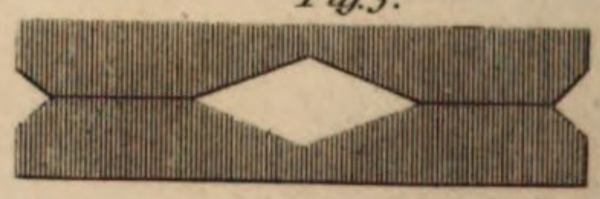


Fig. 6.

Fig. 7.

Fig 9

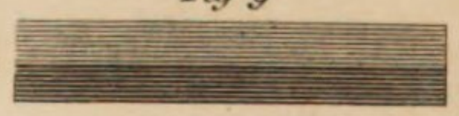
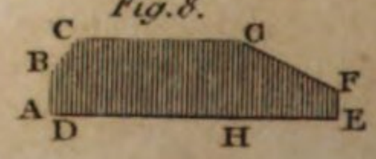


Fig. 10.

Fig. 8.



Scale of 7 Inches.

PLATE XLIX.

Draining-Bricks.

[*To face Page* 332.]

Fig. 1. REPRESENTS the form and manner of placing bricks, invented by Mr. Aſhworth of Turton, near Bolton, in Lancaſhire, in the draining of land, in which 84 bricks are required to every eight yards, while with common bricks 192 are neceſſary; of courſe there is a ſaving of 108 in this way in every eight yards of draining.

Fig. 2. Is another form of brick, in which 55 bricks are ſufficient for draining eight yards in length; by which 137 bricks are ſaved in that diſtance.

Fig. 3. Is a form which takes 110 bricks to complete a drain of the ſame length; by which 82 bricks are ſaved. This form is only neceſſary where much water is to be conveyed away.

Fig. 4. Is another form which employs and ſaves bricks in the ſame proportions as *fig.* 1.

Fig. 5. Is another form of brick that employs and ſaves in the proportions of *fig.* 3. It is particularly uſeful in draining boggy ſoft lands, and where there are quickſands.

Fig. 6. Is another form that ſaves bricks as in *fig.* 2.

Fig. 7. Another form that takes the ſame as in *figs.* 3 and 5.

Fig. 8. Is a croſs ſection of one of the bricks 7 inches broad and 2 in thickneſs. The perpendicular line from A to B is 1 inch; the ſlope from B to C $1\frac{1}{4}$ inch; the diſtance from A to D by a perpendicular line from C is full $\frac{1}{2}$ inch. The perpendicular line from E to F is $\frac{3}{4}$ of an inch; the ſlope from F to G full $2\frac{1}{4}$ inches; the diſtance from E to H by perpendicular line from G is 2 inches.

Fig. 9. A full length view of the brick, exhibiting the narroweſt ſlope. It is 10 inches from I to K.

Fig. 10. Is another whole length view of the ſame brick the contrary way, preſenting the broadeſt ſlope.

PLATE XLIX.

Draining-Bricks.

[To face Page 332.]

Fig. 1. Represents the form and manner of placing bricks, invented by Mr. Ashworth of Turton, near Bolton, in Lancashire, in the draining of land, in which 84 bricks are required to every eight yards, while with common bricks 192 are necessary; of course there is a saving of 108 in this way in every eight yards of draining.

Fig. 2. Is another form of brick, in which 55 bricks are sufficient for draining eight yards in length; by which 137 bricks are saved in that distance.

Fig. 3. Is a form which takes 110 bricks to complete a drain of the same length; by which 82 bricks are saved. This form is only necessary where much water is to be conveyed away.

Fig. 4. Is another form which employs and saves bricks in the same proportions as Fig. 1.

Fig. 5. Is another form of brick that employs and saves in the proportions of Fig. 3. It is particularly useful in draining boggy for lands, and where there are quicksands.

Fig. 6. Is another form that saves bricks as in Fig. 2.

Fig. 7. Another form that takes the same as in figs. 3 and 5.

Fig. 8. Is a cross section of one of the bricks 7 inches broad and 2 in thickness. The perpendicular line from A to B is 1 inch; the slope from B to C 1¼ inch; the distance from A to D by a perpendicular line from C is full ¼ inch. The perpendicular line from E to F is ½ of an inch; the slope from F to G full 2¼ inches; the distance from E to H by perpendicular line from G is 2 inches.

Fig. 9. A full length view of the brick, exhibiting the narrowest slope. It is 10 inches from I to K.

Fig. 10. Is another whole length view of the same brick the contrary way, presenting the broadest slope.

and poſition of the land, the direction, cutting, and mode of filling the ſuperficial hollow drains employed in ſuch caſes; and, at the ſame time, to the ridging and furrow draining, as well as the looſening of the ſoil to a good depth, when in a ſtate of arable cultivation; as upon a due execution and combination of theſe, the ſucceſs of the drainer muſt greatly depend.

From the great variety that exiſts in the nature of the ground to be drained, it will alſo always be of the utmoſt conſequence to aſcertain, with accuracy, from what ſource or cauſe any wetneſs of land, which is to be removed, ariſes, before the buſineſs of draining is begun; as without a conſiderable degree of caution in this reſpect, many unneceſſary drains may frequently be cut, and much money expended without advantage; as the work muſt be managed very differently in caſes where it proceeds from ſurface-water merely, and thoſe in which it depends upon the dribbling of land, or other ſprings.

SECTION IX.

Paring and Burning.

Paring and Burning—Practice of, adopted at an early Period—A Proceſs in which various Changes are produced in Soils—Some of which probably leſſen Fertility—Others greatly promote it—Conſumption of vegetable and animal Matters prejudicial—The Converſion of the freſh vegetable Products into ſaline Matters highly beneficial—Combination of Oxygen with the Soil of great Utility—The ſaline Matters ſeem to be the Cauſe of the great Luxuriance of Crops after—Muſt tend to exhauſt the Land—Great ſtimulant Power of, uſeful in promoting Vegetation—Manner in which Lime may be uſeful when uſed with the Aſhes—Injury only done by the Loſs of vegetable or animal Matters—The earthy Matter not capable of being leſſened by—Frequently left in a more pulverizable State—Loſs of vegetable Matter probably not ſo much as ſuppoſed by ſome Writers—Aſhes produced in the Proceſs ſhewn to be highly uſeful—Nature of the ſaline Subſtances—Fixed Alkali and vitriolated Tartar, both uſeful for the Purpoſe of Vegetation—Other Modes in which the Proceſs may be uſeful in promoting the Growth of Crops—By the Reduction of all Sorts of coarſe vegetable Materials—Rendering them more readily acted upon by other Subſtances in the Soils—By preventing the Land in this Way from becoming too open and light for Grain-crops—By the Earth, in many Caſes, being rendered more mellow and fine, and thereby more ſuitable for the Reception of the Roots of growing Plants—By the complete Deſtruction of Weeds, in ſome Inſtances, the Lands are more at liberty to ſupport the cultivated Crops.—The Practice probably more adapted to ſome Sorts of Lands than others—Leaſt uſeful on the thin, light Soils, or ſuch as have been in Tillage—Moſt advantageous on the ſtiff, heavy, coarſe, and ſour Soils; or ſuch waſte Lands as are infeſted with coarſe Productions of any Kind—This ſupported by the general Experience of Agricultors—The Reaſon of, explained—The Opinion of an able Writer upon—On moſſy or peaty Soils muſt be practiſed with great Caution—Improper for the Operation in ſome Caſes—Dr. Anderſon's Opinion againſt the Practice on—A Fact reſpecting, in other Sorts of Land—Improper Management probably the Cauſe of—May however ſometimes be employed on them—More Caution neceſſary than in other Soils—The Practice general on the coarſe, waſte, heavy Sorts of Soil—Utility and Advantages of, acknowledged by moſt Writers on Agriculture—Mr. Middleton's Opinion of in breaking up Land—Thoſe of others ſtated—Cauſes of Objection to the Practice of Paring and Burning—Origin of—No Loſs of Soil in, but from the vegetable or elaſtic Matters—This not ſo great as ſuppoſed—Clayey Soils ſuppoſed by ſome to be moſt liable to Injury from improper Management of—By others ſuppoſed uſeful in mellowing the Soil—Mr. Young's Opinion of the Objections made to, in Fen Diſtricts—Facts ſhew little Danger to exiſt when properly performed—Differences in the Method

of performing the Operations—Probably neceſſary from the Differences of Soil—Manner of proceeding moſt uſeful in different Caſes—Implements employed in the performing of, different—Advantages of each—Hand Tools in general moſt effectual—Ploughs moſt expeditious when they can be uſed—Seaſon for the Proceſs—Dry Weather highly neceſſary—Spring Months generally the beſt—Muſt vary from the Nature of Crops—For Rape and Turnips—For Barley—For Wheat—Thickneſs of Parings ſhould depend on the Nature of the Soil—Mr. Boys' Opinion of—Uſual Depths of—Circumſtances to be regarded in ſpreading the Aſhes—Particular Mode of, in ſome Places—Objections to—Expences of, in lighter Sorts of Soils—In Fen Diſtricts—Manure produced by—Moſt advantageous Methods of cropping after the Proceſs in different Caſes—Eſtimates of the Expence and Profits of—Utility of the Practice—How may be rendered leſs neceſſary—General Obſervations on.

THE practice of bringing land into a ſuitable condition for the growth of grain or other crops by means of fire, or the operation of paring and burning the ſurface or ſward, is probably a method of cultivation that was adopted at a very early period. It is a proceſs by which various changes are produced in the materials of the ſoils on which it is employed; ſome of which would ſeem to leſſen rather than improve their fertility, while others have obviouſly the power of promoting and augmenting it in a very conſiderable degree.

The action of the fire during the time of the combuſtion, eſpecially when carried to a great height, by forcing off and diſpelling much of the moiſture and elaſtic principles that they contain, as well as by reducing the proportions of vegetable and animal matters which may be mixed and incorporated with them, muſt have the effect of producing ſome degree of deterioration; while by its converſion of the freſh vegetable products, as the different kinds of coarſe plants and graſſes, into aſhes of an alkaline, ſaline nature—which, as has been already ſeen, poſſeſs the property of quickly rendering the portions of vegetable materials which may remain, proper for ſupplying the nutrition of plants—and by combining oxygen with the argillaceous, earthy, or other particles contained in them, in ſuch a manner as to be eaſily parted with during the incipient ſtages of vegetation, great advantage and improvement muſt unqueſtionably in many caſes be produced. It would ſeem to be chiefly on the former principle that the crops are generally found to be ſo abundant after land has undergone this proceſs; as the ſaline ſubſtance contained in the aſhes, though frequently ſmall in quantity, by bringing ſuch parts of the ſoils as were not before in a fit ſtate for the purpoſe of being applied to the ſupport of vegetables, ſuddenly into that ſituation in which they may be taken up by the abſorbent roots of the plants, a vaſt immediate fertility may be given, but which muſt ſoon have the effect of ex-

hauſting the ground, if graſs or ſome other kind of green crops be not cultivated in due rotation upon it. That ſome effect of this ſort takes place, in ſuch caſes, is ſhewn by the general experience of the moſt correct practical agricultors.

There is alſo another way in which the ſaline matter thus formed may be conducive to the purpoſes of vegetation, which is, by the great ſtimulus which it is known to afford to the roots of growing plants, by which they may be induced to take up a larger proportion of nutrient matters from the ſoils on which they grow. And on lands prepared in this manner, eſpecially where they are of the clayey kinds, it is probable that in ſome inſtances ſo much oxygen may be combined, by means of the fire, with the particles of the clay, as, in particular ſituations and circumſtances, to render it capable of forming nitrous acid ;—as is the caſe with imperfectly-baked bricks *, which, where lime is made uſe of at the ſame time with the aſhes, may conſtitute a ſort of calcareous nitre ;—a ſubſtance which experiment has ſhewn to be highly favourable to the proceſs of vegetation.

In the method of cultivating lands, by means of paring and burning the ſurface, ſuch loſſes or deteriorations of ſoil as may be ſuſtained, muſt evidently, as has been juſt ſtated, be produced by the quantity of vegetable or animal materials which may have been conſumed or diſperſed in the ſtate of carbonic acid or other aërial forms ; as it is ſufficiently known, that not a particle of the real earthy matter of the land can be deſtroyed or carried away by the proceſs ; it being left in moſt caſes, where the buſineſs has been properly performed, probably in a much more mellow and friable condition than it was before the commencement of the operation, and perhaps more ſuited to the abſorption of elaſtic principles from the ſurrounding atmoſphere. A late ingenious writer, however, ſtates the diſadvantage in reſpect to vegetable matter to be nineteen parts out of twenty †; but as he has not informed us what is the degree of loſs of ſuch matter by this proceſs, where it is incorporated in the ſtate of ſoil, or the nature of the experiment from which his concluſion was drawn, we are inclined to believe that in this mode of preparation it is not by any means ſo great, whatever it may be where the vegetable matters are themſelves ſimply ſubmitted to the action of the fire ; eſpecially as in the trials which we have made by burning ſuch ſoils as contained a large proportion of vegetable materials, ſo as nearly to reſemble that of garden mold ; conſequently having conſiderably more than is

* See Darwin's Phytologia, p. 225.

† See Dundonald on the Connection of Agriculture with Chemiſtry, p. 147.

uſually met with in the lands that are ſubjected to the operations of paring and burning, it has not been nearly in ſuch a proportion even under a high degree of heat, which ought in every caſe to be as much as poſſible avoided. And it is further conceived, by the ſame author, that as it is only from the aſhes of freſh or growing vegetables that ſaline matters, ſuch as fixed alkaline ſalts, can be procured, none being produced from the burning of dead or decayed vegetable ſubſtances, the proportion of alkaline or other ſaline matters obtained by the proceſs is ſo ſmall, that if the utility or advantage of the practice depended materially upon them, it would be more economical to purchaſe them*. Experience has, however, ſhewn, that whatever may be the proportion of ſaline matter which is formed in this way, a great deal depends upon the aſhes which are produced; as it has been found by thoſe who have been largely engaged in the practice of this huſbandry, that on thoſe parts where the aſhes were ſpread out upon the land as ſoon as the proceſs was finiſhed, the crops were highly luxuriant and productive; while on thoſe, where they had been from neceſſity taken away, they were very mean and inferior, not being worth more than from an eighth to a tenth of the value of the others†.

The ſaline ſubſtances that are formed during the proceſs of paring and burning, have been found to be the fixed vegetable alkali and vitriolated tartar: in the latter caſe the alkali of the conſumed vegetable matters uniting with the ſulphuric or vitriolic acid, which is frequently found to exiſt in ſome ſtate of combination or other in ſoils‡. Theſe ſubſtances have been found by experiment to be capable of promoting the growth of vegetables in a conſiderable degree §.

But in addition to theſe modes, in which the practice of paring and burning may be beneficially employed in the cultivation of land, there are ſome others which ſeem of a more mechanical nature; ſuch as its reducing the various kinds of coarſe vegetable productions, as heath, furze, different ſorts of dwarf ſhrubby plants, tough benty graſſes, ruſhes, and many other aquatics, into ſuch a powdery carbonaceous ſtate‖, as that, by the ready action of other ſubſtances upon them when thus reduced in the ſoils, they may become uſeful in promoting the growth of proper kinds of vegetables; but which, without undergoing this proceſs, could not by any means, from their great elaſticity and

* See Dundonald on the Connection of Agriculture with Chemiſtry, p. 148.
† See Young's Agricultural Report of Lincolnſhire, p. 257.
‡ See Dundonald, p. 149, § See Home's Experiments.
‖ See Kerwan on Manures, p. 90.

almoſt indeſtructible properties, be prevented, for a very conſiderable length of time at leaſt, from rendering the ground too light and porous for growing any ſort of grain crops.

The ſtate or condition of the ſoils, in ſo far as reſpects their textures, as has been already ſuggeſted, muſt likewiſe in many caſes be greatly improved, being by ſuch means, when properly performed, rendered much more mellow and powdery, and thereby more proper for the admiſſion of the fibrous roots of the growing plants, as well as more capable of minutely dividing the particles of the manures, of whatever kind they may be, that are afterwards applied to them, and conſequently of affording a more full and equable ſupply of nouriſhment to the crops that may be cultivated.

And further, from the proceſs radically deſtroying, in moſt inſtances, when well performed, all ſorts of plants of the weed kind that may have eſtabliſhed themſelves in the ſoils which are ſubjected to the operation, the lands are left perfectly clean, and therefore in the moſt proper ſituation for affording the whole of the nutritious properties which they contain to the ſupport of the crops that may be put upon them.

From this view of the manner in which the proceſs of paring and burning may contribute to the improvement of land, the nature of the products that are formed by it, and the effects which they produce on the ſoils, it would however appear to be a mode of cultivation more adapted to ſome ſorts of land than others; as where they are light or thin, and there is much vegetable matter accumulated within the ſoil, whether from the decay of ſucceſſive crops of different ſorts of plants, for a great length of time, or the repeated applications of manures, without their having much ſward or coarſe vegetable products, ſuch as have been mentioned, growing upon the ſurface, it may do harm, eſpecially when a great degree of heat is not carefully guarded againſt, and judicious modes of cropping introduced, by leſſening the quantity of uſeful vegetable matter which they contain, without ſupplying any thing as a compenſation. But where they are more ſtiff and heavy, and there is a thick matted ſward (diſpoſed to the production of moſs, or covered with any ſort of rough, ſour plants, whether of the graſs or other kinds), it muſt, when cautiouſly practiſed, be a highly beneficial, and perhaps, in many caſes, an indiſpenſable mode of cultivation; not only by rendering them more open and porous in their textures, and reducing the coarſe vegetable maſs into that ſort of form in which it can be readily turned down and incorporated with the earthy materials, but alſo by

ſupplying a portion of ſaline matter that may operate ſtill further in promoting their fertility.

That theſe are the effects of the proceſs, and the caſes in which it ſhould be rejected or employed, ſeems evident, from the experience of the moſt exact and careful practical agricultors. It has been obſerved by an intelligent inquirer, who ſeems to have paid great attention to the effects of the different modes of practice that are employed in different diſtricts in the cultivation of land, that ſuch ſoils as are light and friable are every-where conſidered as unfit or improper for being treated by means of this proceſs *. And a very experienced writer, who appears to have cautiouſly examined the nature and effects of the operation, aſſures us, that he has many doubts about the propriety of extending the practice to ſuch ſoils as have been already fertilized and brought into a proper ſtate of tilth by the application of manures. "All kinds of earth," ſays he, "though they be in their original ſtate when dug from a great depth, infertile, become more fertile by degrees on being expoſed to the air on the ſurface, when impregnated by manures, and the gradual rotting of the roots of plants that grow upon them, along with the intermixture of the remains of animals that die there. They are thus in time converted into that kind of ſubſtance which we call *vegetable mold*. This vegetable mold, then," ſays he, "is neither a ſimple earth, nor a mixture of any number of ſimple earths together, but it is ſuch a mixture impregnated with the remains of animal and vegetable matters united with them. Theſe remains of organized bodies," he thinks, "communicate ſomething to the ſoil of an apparent oily or mucilaginous nature. Along with the fertility which it is thus ſeen to acquire, theſe give it a more friable texture and a greater facility than it originally poſſeſſed of abſorbing water in a proper manner, and retaining it to a certain degree. Now," ſays he, "there ſeems to be little reaſon to doubt that fire tends to alter, deſtroy, or diſſipate this mucilaginous quality which the mold derives from the ſpontaneous corruption of organized bodies. So that wherever the ſoil has been gradually fertilized by this proceſs, there ſeems reaſon to fear that the burning of its ſward will rather prove hurtful than beneficial †." It is, indeed, afterwards ſuggeſted, that theſe are given as reaſons for doubting of the propriety of the method under ſuch circumſtances, but not by any means as rules for practice. The reaſoning appears, however, to be founded in truth, and to be ſupported by

* See Donaldſon's Preſent State of Huſbandry in Great Britain, vol. III. p. 388.

† Anderſon's Eſſays, vol. III. p. 255.

the few facts and experiments that have been recorded in such a way as to be in any degree depended upon.

There is also another sort of soil on which the process of paring and burning must be practised with equal caution, or perhaps in some cases be wholly rejected, from the danger there is of its reducing the materials of which it is constituted in too great a degree. This is that of the *peat* or *mossy* kind. "In this case," says the able author mentioned above, "it is not the plants which grow upon it, but the very substance itself that served as a soil on which the plants grew, that is totally destroyed by incineration. This substance is," continues he, "by burn-beaking, amazingly diminished in quantity; and the little that remains, instead of soil, after this destructive process, is an inert earth, which is more unfit for the purposes of vegetation than any other that has ever fallen under my observation*." He therefore conceives the burning of such a soil as pernicious in every case, but more especially so where there is no possibility of stopping the combustion, after a thin paring of the surface or sward has been consumed, and to stop its progress just at that moment he knows to be a matter almost impracticable. This is not, he assures us, the result of mere opinion; it has been confirmed by innumerable proofs of the practical kind. And it has been observed by others, that this has been the case in other sorts of land; and that a material objection to paring and burning is, that in very dry seasons, when the moisture of the earth is very low, the fire catches the soil below and causes what is called *pitting*; making great unsightly holes to the bottom of the moor, which with great difficulty are extinguished. About thirteen years ago a large common at Chatteris, in the Isle of Ely, it is said, was thus burnt up sixteen or eighteen inches deep, to the very gravel†. These are, however, we suspect, in many instances at least, the effects of misconduct or improper management, and of course afford little real objection to the practice when well executed.

We believe, indeed, notwithstanding the above opinion, supported as it is by the great experience of the ingenious author, that in some cases mossy soils may be subjected to the process of paring and burning with much benefit to the cultivator, provided that it be performed with proper care and attention. And it is unquestionably practised in various districts without any injury being produced by the destruction of the materials that constitute such soils‡. On such kinds

* See Anderson's Essays, vol. III. p. 257.

† See Agricultural Report of Lincolnshire.

‡ See Agricultural Report of Lancashire, p. 109. And of the West Riding of Yorkshire, p. 149.

of ſoil more care will, however, probably be requiſite to prevent the fires from becoming too violent, than in ſuch as are compoſed of more earthy or leſs combuſtible ſubſtances.

But where the ſoils are of the latter deſcription, or ſuch as are of the ſour, heavy, ſtiff, and fenny kinds, and where they are overgrown with ſuch coarſe vegetable productions as have been already mentioned, there cannot be the leaſt doubt entertained of the propriety of adopting ſuch a method of practice in breaking them up and bringing them into a ſtate of cultivation. Indeed, however much the writers on agriculture may have differed in opinion on the propriety of paring and burning in other caſes, in theſe they ſeem to be nearly agreed, and in general conſider it as the moſt advantageous and ready method that can be employed.

On incloſing the waſte lands in the pariſh of Bows, in Yorkſhire, large portions, it is ſaid, were ſubjected to the proceſs of paring and burning; but the few perſons who ploughed up the ground without previouſly employing this method, had great reaſon to regret it *.

It is alſo remarked by an able writer, in ſpeaking of bringing into cultivation the chaſe lands in the county of Middleſex, that the impropriety of breaking up this kind of land without paring and burning, is manifeſted in the neighbourhood of Beech-hill, where land, after twenty years' incloſure and cultivation, is in a worſe ſtate now than it was originally. Well would it be for the owners of ſuch allotments, ſays he, if they could now pare and burn it; but it has been ploughed, and not producing more than what the vermin deſtroyed, laid down in ſo rough a ſtate to graſs, as to be incapable of being pared and burnt: the original wiry bent and dwarf ſhrubs are now growing in full vigour: and that on the incloſure of Stanwell, in the ſame county, the allotments on Hounſlow-heath ſucceeded well under the perfect practice of paring and burning; and ill, where the turf was ploughed without the application of fire. In the former caſe the land was immediately fit for turnips, tares, barley, and clover: in the latter, the tough, wiry bent, heath, and dwarf furze, kept the land too light and ſpongy for any crop. Even rolling, he aſſerts, cannot keep it down, for its elaſticity raiſes the ſoil ſoon after the roller has paſſed over it, and it is of ſo imperiſhable a nature, that it is likely to plague the farmer for many years. The difference between the two methods of breaking up rough ground, is, he thinks, more than the value of the freehold in favour of paring and burning,

* See Annals of Agriculture, vol. XII. p. 253.

which immediately opens a ſource of great profit; whereas the other proceeding leads to nothing but expence and diſappointment.

And in addition to this it is obſerved, that paring and burning has more merit than any other manure, in its property of converting heath, furze, ſhrubs, and wiry bent, into coal, moſt fitly prepared for the food of plants; and that it will pulverize ſuch a ſoil as much in two years as all other means can effect in twenty *.

And others contend, that on any ſort of ſoil which has not before been reclaimed from a ſtate of waſte, and where furze, broom, brambles, ferns, ruſhes, &c. abound, theſe operations, when properly performed, are productive of the moſt beneficial conſequences. That there is perhaps no other method that could be deviſed, ſo well adapted for preparing land in a ſtate of nature, and incumbered with ſuch productions, for valuable crops with expedition and certainty; and that on this account, paring and burning might well be conſidered by Virgil, and other ancient writers, as a ſure means of improvement. And further, that in ſuch caſes they are ſo at this period, may, it is thought, be proved by the concurring teſtimony of thoſe to whoſe lot it falls to cultivate the common or waſte lands in many of the new incloſed diſtricts of the kingdom. It is further ſtated, that inſtances are frequently met with of great advantage reſulting from this mode of management; and that wherever land is rendered unfit for cultivation by the incumbrances that have been mentioned, the Devonſhire mattock and the paring-ſpade may be uſed with the greateſt propriety†.

It has been likewiſe remarked by Mr. Young, in the Agricultural Survey of Suffolk, that "in that diſtrict they could not cultivate without this capital aſſiſtant. It is ſcarcely poſſible, profitably, to bring boggy, moory, and peat ſoils, from a ſtate of nature into cultivation, without the aſſiſtance of fire, which is the moſt effective deſtruction of the ſpontaneous growth, and never fails, but becauſe the men employed do not pare deep enough."

From ſuch caſes as have been ſtated above, where much deſtruction has been produced by the improper management of the burning in a particular ſort of land, the notion of the ſoil itſelf being leſſened, which has formed a great objection to the practice, ſeems to have originated; but it has been already ſhewn, that no loſs can poſſibly take place, but from the conſumption of a ſmall por-

* Middleton's Agricultural Survey of Middleſex, p. 290.

† See Donaldſon's Modern Agriculture, vol. III. p. 389.

tion of the vegetable material that may be contained in it, either in a living or decayed ſtate, or the diſſipation of moiſture and elaſtic matters; and that there is reaſon to ſuppoſe the loſs in theſe reſpects is not ſo great as has been commonly imagined.

It has been remarked that clay ſoils are much more apt to be injured by paring and burning than any others. Where the flame in the heaps is allowed to burſt out with great violence, the ſoil is apt to be reduced to a bricky ſort of ſubſtance, incapable either of imbibing any quantity of moiſture, or of again becoming uſeful in promoting the growth of plants; hence, in ſo far as miſmanagement takes place in this reſpect, in ſo far is the depth of ſoil permanently leſſened. But were paring and burning to leſſen the ſoil to the degree which ſome people aſſert, there would not have been an inch of ſoil in the counties in the ſouth-weſt part of the iſland many years ago. Such an objection to the practice of paring and burning, does not therefore appear to carry much weight along with it. It is no doubt very ſpecious and plauſible in theory, but the practice of ages has proved it in a great degree ill founded *. But by others it is contended, that the large portion of powdery brick earth produced in this way has a tendency, by being incorporated with the ſtiff retentive mold, to render it more mellow and pulverizable †; an effect which we have already ſuggeſted as uſeful in promoting the growth of crops.

Mr. Young, in ſpeaking of the different objections which have been made to this practice in fen diſtricts, from the ſuppoſition that it tends to reduce the ſoil greatly, as is evinced by the ſinking of drained lands that have been pared, ſays, that it has been found that a ſeries of ploughing and cropping ſtiffens, concentrates, and diminiſhes the lighter kinds of fen ſoils; and that the ſtratum of black peat earth, which on their firſt breaking up was conſiderably deeper than the plough ran, has been within the memory of the preſent occupiers, without any freſh paring and burning, ſo far reduced, that without taking more mold, or ploughing deeper than they formerly had been accuſtomed to do, they have not only paſſed the whole of the black peat ſtratum, but have ploughed up two or three inches of the clay beneath it; and that if it be granted, which he thinks will ſcarcely be denied, that the ſurface of the adjacent depaſtured fen lands, from the decay of vegetables, dung of animals, and the ſoil brought thither by the waters from the neighbouring high lands, has been continually, though ſlowly, increaſing, there will then appear other reaſons for their preſent

* See Modern Agriculture, vol. III.

† See Anderſon's Eſſays, vol. III. p. 252.

different level than mere paring and burning. "It is well known," ſays he, "that earth is not to be diſſipated by combuſtion; it is more likely that this appearance proceeds in the firſt place from the light peaty earth of a fen ſoil being gradually conſolidated by alternate cultivation and paſturage, ſo as to ſink below the level it formerly preſerved in its uncultivated ſtate; and in the next place, may it not proceed from the commons gradually riſing higher by the accumulation of mud and ſoil depoſited by the upland waters?"

Theſe facts, which ſeem to reſt upon the foundation of practical experience, ſufficiently ſhew that little danger is to be apprehended from the deſtruction of the ſoil when the proceſs is properly performed, and a correct method of after-management purſued.

In the method of performing the proceſs of paring and burning, there are ſome ſlight differences in the practice of different diſtricts; and perhaps in managing this buſineſs, an attention to the nature of the lands may be as neceſſary as in other caſes of huſbandry, as it would ſeem that ſome, as thoſe of the more clayey and heavy kinds, would be moſt benefited by having the fire to come as much as poſſible into contact with the whole of the ſuperficial parts of them, without being carried too far, as by that means they may be rendered more proper for the reception of the roots of vegetables after being ſlightly ploughed, as well as more ſuitable for ſupplying nouriſhment to them; while in others, as thoſe of the more light and thin deſcriptions, it might be moſt advantageous to merely conſume the thin paring of ſward after being piled up for the purpoſe, without permitting the fire to exert its influence upon the mold or ſoil immediately below, as in this way there would not probably be ſo much danger of injuring the ſtaple, by deſtroying the vegetable matters contained in ſuch ſoils.

In the firſt of theſe modes of burning the ſward, it is obvious, that the ſods or parings ſhould be piled up as little as poſſible into heaps, the advantage of a ſuitable ſeaſon being taken to apply the fire to them in the ſtate in which they lie, or are ſet at firſt after being cut up, or after a few only have been placed together, as happens in ſome inſtances where they are immediately after being cut, ſet on edge to dry, and placed in ſerpentine directions, in order to prevent them from falling over; but in the latter caſes they ſhould be formed or built up into little circular heaps or piles, ſomewhat in the form and ſize of the little cocks made in hay-fields, the ſods being placed the graſs-ſide downwards, in order to admit air; but the openings both at the bottoms and tops, after they have been fully ſet on fire by ſome combuſtible ſubſtance, ſuch as ſtraw, &c. are

to be cloſed up, as well as thoſe in other parts covered by an addition of ſods; ſo as that the combuſtion may proceed in a ſlow, ſmothering manner, ſuch as is practiſed in the making of charcoal. When the whole of the earth in each of the piles has been acted upon by the fire, the heaps may be ſuffered to extinguiſh themſelves by ſlowly burning out.

There is another method of practice of this kind, which is much in uſe in ſome diſtricts, as in Devonſhire and Cornwall, for breaking up and preparing graſs lands for the reception of what have been termed fallow crops, which is that of *ſkirting*; in performing which a part of the ſward or ſurface is alternately left unturned, upon which the next thin furrow ſlice is conſtantly turned, ſo that the ſwards of each come in contact, by which means the putrefactive fermentation is ſpeedily excited, and the greateſt part of the graſſy vegetable matter converted into manure; what ultimately remains undeſtroyed being, after repeated croſs-cuttings with the plough and harrowings, all the mold or earthy matter having been previouſly well removed from the roots of the plants by ſhaking, collected into ſmall heaps (which is done either by the hand or with iron-headed rakes, conſtructed for the purpoſe), and burnt, the aſhes being then ſpread evenly over the land *. The operation when managed in this way is termed *beat-burning*, and would appear to be the moſt proper and uſeful on land where the turf or ſward is not very tough or matted together, and where there is little or no coarſe vegetable products growing upon it.

In accompliſhing the operation of paring, or of ſeparating the ſward from the ſurface of the ſoil, ſeveral different inſtruments are made uſe of in different parts of the kingdom: that which was the moſt employed in the infancy of the art was a kind of curved mattock or adz, about ſeven or eight inches in length, and five or ſix in breadth; and which from its ſhape would appear to have been better adapted for cutting up the roots of bruſh-wood, furze, broom, or other coarſe ſhrubs, than for paring off the ſurface of a field free from ſuch incumbrances. This inſtrument is, however, it is ſaid, common in the ſouth-weſtern diſtricts; and that, though it no doubt retains in a great meaſure the ſhape of the inſtruments firſt uſed for the purpoſe in that part of the country, when the lands were in a very different ſtate, yet the labourers who are in the practice of uſing it, are able to pare off the ſod with great dexterity and diſpatch †. But in other diſtricts, where the ſod is pared off by manual labour,

* See Agricultural Report of Devonſhire.

† See Modern Agriculture, vol. III.

the ordinary *breaſt-ſpade*—in ſome places called the *breaſt-plough*, and in Scotland the *ſaughter-ſpade*—is moſtly employed. The iron or cutting part of this implement is about eight or nine inches in length, and from ten to twelve in breadth, having frequently a kind of edge riſing up a few inches at the right-hand ſide of the turf next to the unmoved ſward. This inſtrument, which is formed with a fine edge, is forced forward by the ſtrength of the arms of the perſon uſing it, and by preſſing the breaſt againſt that part of the frame or ſhaft which is held in the hand. In working the tool, the labourer generally cuts the ſods at about an inch or an inch and a half thick, and from ten to twelve broad; and when the ſpade has run under the ſod to the length of about three feet, he throws it off, by turning the inſtrument to one ſide, and proceeds in the ſame way, cutting and throwing over the ſods, the whole length of the ridge. In this way of performing the operation the labourers, by following each other with a ſlice of the ſward or ſurface of the land, accompliſh the buſineſs with much eaſe and expedition.

Another inſtrument that is ſometimes uſed for paring the ſod is the *horſe-paring-plough*, an implement made of different conſtructions, according to the circumſtances of the ground to be pared. In the fenny diſtricts on the eaſtern coaſts, where paring and burning is practiſed on a large ſcale, they have ploughs conſtructed for the purpoſe of a particular form, but which vary from the common ploughs chiefly in the breadth and ſharpneſs of the ſhare or ſock. They are admirably calculated for paring off the ſward or ſod of ſuch grounds as are level, and where neither ſtones, bruſh-wood, ant-hills, nor other impediments obſtruct their progreſs; but where ſuch obſtructions preſent themſelves, the breaſt-ſpade or common team-plough, with a ſmall alteration of the ſhare, will be found preferable, both in reſpect to the extent of ground that can be pared, and the ſuperior manner in which the work in ſuch caſes can be performed *. Ploughs, from their great expedition and regularity of performing the buſineſs, ſhould always probably be made uſe of where the nature and ſituation of the land will admit them, in preference to ſuch tools as require manual labour. In ſome of the weſtern counties the common plough only is uſed. There the old graſs-fields, when it is propoſed to burn the ſward, are *rib* or *ſlob furrowed* about the beginning of winter; and being again croſs-ploughed the following ſpring, the ſods are collected and managed in the manner mentioned in ſpeaking of ſkirting. In theſe caſes the plough has, however, a

* See Modern Agriculture, vol. III.

wing turned up on the furrow ſide of the plough-ſhare, by which the furrow is cut any breadth required. The work is alſo ſometimes done by means of the ſpade, mattock, and breaſt-plough, in ſuch caſes.

In reſpect to the ſeaſon for performing this operation, it may be obſerved, that the months in which the greateſt quantity of land is pared and burned are April, May, and June: the particular period muſt, however, always depend much on the ſtate of the weather, the nature of the crop, and the farmer's convenience. But for accompliſhing the work with the greateſt diſpatch, and alſo with the leaſt trouble and expence, a dry ſeaſon is obviouſly the beſt. The prudent farmer ſhould not embark in the undertaking, unleſs there be a reaſonable probability of his accompliſhing it while the weather keeps dry and favourable. The latter end of May or the beginning of June, when the hurry of the ſpring ſeed-time is over, in the more northern diſtricts, when a number of hands can be moſt eaſily procured, may upon the whole be conſidered as the beſt and moſt convenient ſeaſon; as at this period the green vegetable products are in their moſt ſucculent and full ſtates, and of courſe may probably afford more ſaline matter; but in the more ſouthern counties either a much earlier ſeaſon muſt be taken, or the interval between the hay ſeaſon and the harveſt-time muſt be fixed upon, the latter of which is, on the principle juſt ſtated, evidently the beſt, where the extent of ground to be burnt is not too large. In other ſeaſons it would frequently be impoſſible to procure a ſufficient number of hands for performing the buſineſs. In bringing waſte lands into cultivation, where an extenſive tract of ground is to undergo this proceſs, the autumn may in many caſes afford a convenient opportunity for the operation.

As the crops that are ſown after paring and burning are various, and as the ſeaſon for performing the proceſs muſt in many caſes depend in ſome meaſure on their nature, we may obſerve that when rape or turnips, which are the moſt prevailing crops in ſuch circumſtances, are to be cultivated, the end of May or the beginning of June will be the moſt proper time: but if barley or oats be to be ſown, the paring and burning muſt be completed as early in ſpring as the nature of the ſeaſon will admit; and when lands are pared and burned as a preparation for a crop of wheat, July, or even the beginning of Auguſt, may in favourable ſeaſons anſwer; but it is better to have the ground ready ſooner.

The depth to which lands of different qualities may be pared with the moſt advantage, is alſo a point that would ſeem to require ſome attention in the conducting of proceſſes of this nature; as it can hardly be proper to pare light, thin, ſtapled ſoils, to the ſame depths as thoſe of the more deep and heavy

kinds. This ſhould probably, in ſome degree, be regulated by their particular nature, and their differences in reſpect to ſtaple and heavineſs. Mr. Boys, however, who is in the habit of breaking up thin chalky ſoils, and ſuch as have been in tillage in this way, obſerves, that in Kent, where the method of paring moſt in uſe is with down-ſhares or breaſt-ploughs, they take off turfs as thick as the nature of the ſoils will admit, from half an inch to two inches; the *thicker* the *better*, provided there be a ſufficient portion of vegetable matter contained within them to make them burn well*. The moſt uſual depths of paring are, however, from one to three or more inches.

When the ſeaſon is not very wet, the turfs will commonly be ſufficiently dried in about a fortnight or three weeks, even without being turned; but in rainy weather they require a longer time, and muſt be turned more than once to prevent their ſtriking out roots and ſhoots, which might hinder them from burning.

When the turfs have fully undergone the proceſs of burning, and are reduced to the ſtate of aſhes and a powdery earthy matter, the whole ſhould, as ſoon as poſſible, be ſpread out over the land in as regular and equal a manner as the nature of the work will admit of; for without great attention in this reſpect, great inequality in the crops may take place; beſides the ſoil will be made lighter in ſome places than in others, which may be diſadvantageous in the ſame way. The ſpreading, where it can by any means be accompliſhed, ſhould always be performed before any rain falls; as where this point is not attended to, a great loſs may be ſuſtained by the ſaline matters being carried down in a ſtate of ſolution, and their beneficial effects in a great meaſure loſt before the crops are in a condition to receive them. In order to ſecure the full influence of the aſhes, the land is frequently ſlightly ploughed over immediately after the aſhes are ſpread out. And it is ſtated by Mr. Donaldſon, that "thoſe who are more than ordinarily attentive in this reſpect, only rib or ſlob furrow the field, ſo that the aſhes may be got covered up with the greater expedition and diſpatch." By this mode they cannot probably, however, be ſo equally mixed with the ſoil as by that of ploughing the whole field with a very ſlight furrow, ſo as juſt to cover them.

The expence of preparing lands by the operations of paring and burning, muſt obviouſly vary according to the nature and ſituation of the land, the method in which they are performed, and the cuſtoms of the diſtrict in regard to the price of labour. On the thin ſort of chalky ſoils it is obſerved by an expe-

* See Agricultural Report of the County of Kent.

rienced agricultor, who is accuſtomed to have ſuch lands prepared by this means, that the expence for paring at a moderate thickneſs, where the land is not very flinty, is twenty ſhillings per acre; for laying it up in heaps and burning, ten ſhillings; and for ſpreading the aſhes, three ſhillings; and that a coat of manure is thus produced on the land of from eighty to one hundred and ſixty cart-loads per acre, for the trifling expence of thirty-three ſhillings. A hundred cart loads of dung purchaſed from neighbouring towns and villages, at the diſtance of three miles from the land, would, he ſays, coſt, carriage home included, ten times the price of down-ſharing, and yet would not improve the land more. But that, where the land is well covered with turf, it may be ploughed for burning about two inches deep, with a common plough, drawn by a pair of horſes, early in the ſpring, and as ſoon as a drying wind ſets in, the turf be laid in heaps and burnt by labourers for one pound one ſhilling per acre, which will produce near two hundred cart-loads *. As the author has not informed us of the quantity contained in ſuch loads, it is impoſſible to decide with any certainty in regard to the benefits of the proceſs in ſo far as manure is concerned; but his ſtatements fully ſhew that it is more conſiderable than is generally ſuppoſed.

And in ſome fen diſtricts, where the original ſurface is rough and unequal, from great tufts of ruſhes, &c. called *haſſocks*, Mr. Young obſerves, that ſome perſons cut them with ſpades at the expence of five to ten ſhillings an acre, and others with the plough. Paths for the horſes are in that caſe to be cut by hand, and the plough made on purpoſe, and called a *haſſock-plough*, cuts laterally much beyond the line of its draught. But opinions are ſaid to be in general, that the hand-work is the cheaper; in either caſe, the haſſocks are dried, heaped, burnt, and the aſhes ſpread. After this they go over it again with a very complete and effective tool, called a *fen-paring plough*, the furrow of which is burnt †.

In the management of land by means of paring and burning, it will conſtantly be neceſſary to attend to ſuch a mode of cropping as will tend to its improvement, whatever may have been the manner or kind of ſoil in which the proceſs was performed. Without a nice and exact attention in this reſpect, much injury may frequently be done, and an uſeful practice be brought into diſrepute. When the nature and ſituation of the land will admit of them, as in the lighter ſorts of ſoils, the growing of turnip or rape crops to be conſumed on

* See Agricultural Report of the County of Kent.

† See Agricultural Survey of the County of Suffolk.

the ground would ſeem to be moſt proper for the firſt year; then a white or grain crop, as oats, or wheat; after that, turnips again, or in ſome caſes, peas, beans, or ſome ſort of green crop, to be eaten off if poſſible by ſheep; and laſtly, a grain crop with graſs ſeeds: but on the heavier ſorts of land, where the turnip huſbandry cannot be ſo well introduced, cole, clover, and bean crops, may often be interpoſed between thoſe of the grain kinds with the moſt propriety and advantage. And it would ſeem that the interpoſition of green crops ought on the whole to be more frequent in the former ſorts of ſoil than on thoſe of the latter, on account of their containing, in general, a leſs proportion of vegetable matter. It is often attended with great advantage to apply ſome ſort of manure, ſuch as lime, with the ſecond crop of turnips in caſes of theſe kinds.

It is aſſerted, that in ſome of the weſtern diſtricts, where the method of paring and burning is very much practiſed, and held in high eſtimation, old ſainfoin lays, and all ſuch ſwards as are of a ſufficient texture, are uſually broken up in this way. Turnips are frequently the firſt crop; and from the freſhneſs of the land, and the good effects of the aſhes, a large crop is moſtly produced. But as in thoſe caſes the time is too ſhort to get the land in proper tilth for the ſucceeding crops of barley, graſs ſeeds, and other ſimilar crops, it is often adopted as a better method to ſow wheat in the firſt inſtance on one ploughing; after which, from the aſhes being ſtill freſh in the ground, a crop of turnips may be as certainly depended on, and there is a ſufficient length of time to get the land into a complete ſtate of tilth. Wheat ſtubbles, of the more graſſy kinds, which will produce a tolerable quantity of aſhes, are alſo frequently pared and burnt for turnips with a conſiderable degree of ſucceſs. In ſhort, when this practice is properly followed up with the turnip and clover huſbandry, its good effects cannot it is conceived be diſputed *.

In others, cole ſeed is ſown on a ſhallow ploughing, and never harrowed, in order not to diſturb the whole furrow; but rolled, or lightly buſh-harrowed. This is intended either for a crop of ſeed, or for ſheep-food: in the latter caſe, it ſells in ſome places for a guinea an acre; in the former, for two or three guineas. Oats are then ſown; the crop is productive, and the land, if well laid down to graſs, becomes good meadow. But the management in this reſpect is frequently very bad, only clover and ray graſs being ſown, and after ſix or ſeven years pared and burnt again; inſtead of which, if proper ſeeds were ſown, the land would be ever after in a ſtate of improvement.

* See Agricultural Survey of Glouceſterſhire.

Where there are poor, wet, cold, hungry paſtures and neglected meadows, overrun and filled with all ſorts of rubbiſh, and abounding with too few good plants to render their improvement eaſy without breaking up, it is obſerved, that theſe ſhould be pared and burnt; not to keep under the plough, to be exhauſted and ruined, which is infallible, and the land left in a worſe ſtate beyond all compariſon than it was before, but to be laid immediately to graſs, that is, as ſoon as the courſe of huſbandry neceſſary will admit. This, it is conceived, ought to be without variation, under any pretence whatever, in this courſe of crops: 1ſt. Pare and burn for turnips to be fed on the land with ſheep: but in moiſt-bottomed lands, rape will often ſucceed better than turnips; and the ſheep feed better with rape upon ſuch lands. 2d. Oats; and with theſe oats the graſs ſeeds ſhould be ſown. The oats and the turnips, it is aſſerted, would more than pay all the expence of a previous hollow draining, ſhould that be neceſſary; of the paring and burning, and every other charge; and the change, from a very bad paſture to a very fine one, would all be neat profit. The tenant, it is contended, would be greatly benefited, and the landlord find his eſtate improved, if let as farms ought to be let, with an abſolute excluſion of ſelling a lock of hay under any pretence whatever *.

And it is further aſſerted, that this method is practiſed with great ſucceſs in the *fen land* in Lincolnſhire, the buſineſs being performed by means of the plough; and cole ſeed afterwards ſown. In ſome caſes, horſes and ploughs are found, and the labour put out; which, including a ploughing in order to turn in the aſhes, is done at ſeven ſhillings an acre: the cole is fed with ſheep, and is worth three pounds an acre; but ſelling price, forty to fifty ſhillings. Then oats, eight quarters an acre, and ten quarters has been had; then cole and oats again; being laid down with fourteen pounds of white clover, and one peck of ray, the graſs lets at twenty ſhillings. It is found to be a great and laſting improvement of the land. This is conceived to be a low eſtimate, from the land keeping five ſheep an acre, from Lady-day to Michaelmas, and one and a half on the acre in the winter. Where then, it is enquired, is the ſuppoſed miſchief of this practice† ?

There are other ſorts of lands, as dry, rough ſheep-walks, covered with ling, furze, broom, &c. which ſhould alſo be broken up in the ſame manner, but univerſally to be laid down again with the graſſes ſuitable to the ſoil and to ſheep. On weak, thin, ſtapled land, two crops of corn, after paring and burning, may often be pernicious. Perhaps they might be well laid down without a ſingle

* See Agricultural Report of Suffolk. † See Young's Agricultural Survey of Lincolnſhire.

one, which would be a better method of management. It is alſo ſuppoſed by ſome able agricultors, that it would be better to take, in ſuch caſes, two or three ſucceſſive crops of turnips, in order to completely eradicate all the ſeeds of the ling, furze, and broom, before the land is laid down to graſs, as otherwiſe theſe plants may appear with redoubled vigour. Theſe obſervations ſeem juſt, and to be founded in good ſenſe, reaſon, and experiment; they place the abſurdity of indiſcriminately condemning this mode of agricultural improvement in the cleareſt point of view; as the injury that may take place in ſome caſes may be occaſioned by an injudicious and improper method of cultivation.

It is further remarked by an experienced practical agricultor, that, of all the improvements in the cultivation of land that have hitherto been made uſe of in the diſtrict where he reſides, this ſtands foremoſt; ſome of the very worſt land having been made to produce excellent crops; and poor chalky downs, of ſcarcely any value in their original ſtate, are by it made to produce good turnips and clover, and crops of corn, often equal in value to double the fee ſimple of the land. Inſtead of the land being injured by the operation, as ſome theoretical writers have imagined, provided it be under a proper ſyſtem of management and fairly dealt by, it is, he thinks, put into a progreſſive ſtate of improvement from the time of its ſurface being burnt. It has frequently, ſays he, happened, that land after burning has been ſown with corn four or five years in ſucceſſion without being folded with ſheep, or any part of its produce ever returned in manure; even *charlock* and other weeds have been ſuffered to remain, by which it has been annually burthened with a double crop; hence it has been left in an impoveriſhed ſtate, and the burning is unjuſtly condemned for the miſchief done by the negligence and rapacity of the cultivator. Let the land when burnt, continues he, be perfectly cleaned from charlock and other weeds, by growing turnips until the weeds are totally eradicated by hoeing, &c. Let the turnips be fed off the land, by ſheep lying on the land day and night; then ſow it with barley and clover; the latter to be fed off with ſheep, folding them on the land for wheat. Laſtly, return the ſtraw produced upon the land in manure, mixed with clay or loam, or any other freſh earth that is near at hand, for a ſecond Norfolk rotation, which may be repeated; or the land may be ſown with ſainfoin, to remain till a turf is formed fit for paring and burning again. This plan being purſued, the practice of burning the ſoil will, he conceives, not give any cauſe of complaint either to landlord or tenant. Theoriſts, ſays he, exclaim, that by paring and burning the ſtaple of the land is reduced, and the

ſoil is waſted; which may be ſomewhat true: but all this is very immaterial, if fine crops of corn can be produced where none ever grew before, and the land at the ſame time be improved *.

In ſpeaking of the injudicious and improper modes of cropping repeatedly with white or grain crops after this proceſs, an intelligent practical writer forcibly obſerves, that if a dung-hill were given to a bad farmer, and it was uſed on ſimilar principles, it would almoſt equally exhauſt the ſoil; yet who has found out that dunging land is bad huſbandry? Paring and burning gives, ſays he, a dung-hill alſo: it is bad management alone that converts it into an evil. Make it the preparation for graſs, and all is ſafe † ‡.

* Boys's Agricultural Survey of Kent.

† Young's Agricultural Survey of Suffolk.

‡ The practice of paring and burning has been found ſo advantageous in ſome caſes, as to render lands, the produce of which was not worth two ſhillings and ſix pence, in the courſe of four years capable of producing two valuable crops of corn, and as many of turnips, and to be rented at twenty ſhillings per acre.

The expences and returns of breaking up freſh land of the ſtiff loamy kind, and cropping with oats and peas, is ſtated in the following way by Dr. Wilkinſon, in the fifteenth volume of the Annals of Agriculture. The ſummer being loſt in preparing the land for a wheat crop, the crops are, he obſerves, charged with two years' rents and taxes.

OAT CROP.

	£.	s.	d.
Rents, for two years, per acre - -	1	0	0
Poor-rates - - - -	0	3	0
Road levy - - - -	0	1	0
Stocking the buſhes - - -	0	6	0
Paring and burning - - -	1	9	0
Levelling hillocks - - -	0	4	6
Spreading aſhes - - -	0	1	6
Once ploughing - - -	0	10	0
Harrowing - - - -	0	2	0
Four buſhels of ſeed-oats, at 29s. - -	0	11	0
£.	4	8	0
Sold ſeven quarters of oats, at £.1. 1s. per quar.	7	7	0
Seeds and expences - - -	4	8	0
Profit per acre £	2	19	0

Straw, not charged, more than defrayed expences of mowing and threſhing -

The kinds of graſs ſeeds that may be the moſt ſuitable after the operation of paring and burning, muſt evidently be different according to the nature and quality of the land. In the lighter ſorts of ſoil, thoſe kinds of graſſes that cover the earth well will in general be the moſt proper. On chalky ſoil ſaintfoin may moſtly be employed to the greateſt advantage. On the fenny ſorts of ſoil, marle-graſs, with a little meadow foxtail-graſs, will frequently be found the moſt

PEA CROP.

	£.	s.	d.
The expences the ſame as for the oat crop, with the addition of 5s. for four buſhels of ſeed, at 3s.	4	13	0
Sold four quarters of peas, at 32s.	6	8	0
	£. 1	15	0

From the ameliorating nature of pea crops, and the excellent ſtate in which they leave the land for a crop of wheat, they will, it is ſuppoſed, be on the whole more advantageous than the oats.

The expences and profits on cold, moſſy, old meadow lands in Yorkſhire, with a north-eaſt aſpect, cultivated in this way for turnips, as given in the twelfth volume of the ſame work by Mr. Middleton, are theſe:

	£.	s.	d.
Paring	0	9	0
Drying and burning	0	5	0
Spreading the aſhes	0	1	0
Ploughing once	0	6	0
Harrowing	0	2	0
Seed, ¾ lb. and ſowing	0	0	6
Weeding (in pared and burnt land little neceſſary)	0	0	6
	£. 1	4	0
Rent, tythe, taxes, and aſſeſſments	0	18	0
	£. 2	2	0
The turnips, a plentiful crop (large ſizes, about a foot diſtance), eſtimated in feeding ſtock by the acre, at	5	0	0
Profit per acre	£. 2	18	0

It is added, that "in that neighbourhood the uſual agiſtment price is ſix pence a week for fattening wethers, and three pence a week for hogs (lambs of the preceding ſeaſon), to eat the broken turnips and ſhells left by the wethers."

beneficial. And a ſmall mixture of the fineſt ray, or darnel-graſs, is likewiſe found to anſwer well. For marle-graſs, though it has ſome reſemblance to red clover, is materially different in its effects; the former being found unfriendly to all natural graſſes, while the latter is quite the reverſe. This is a fact that has been eſtabliſhed by extenſive experience. One other very material advantage reſulting from the cultivation of marle-graſs, is ſaid to be, that neat cattle are not ſo liable to ſwell by eating it in moiſt weather, as they are from red clover; nor is its hay ſo dangerous to the horſes' wind as that made from clover.

And it may be further obſerved, that the heavy or clayey ſoils will in moſt caſes require the largeſt proportions of graſs ſeeds to be ſown upon them, in laying them down after this preparation.

From the great eaſe and expedition with which all thoſe coarſe ſorts of land, which have been mentioned as proper for being broken up by this means, are rendered fit for the growth of crops of different kinds, ſuch as thoſe of grain, rape, turnips, potatoes, &c. as well as from the very abundant produce, which is generally the caſe after ſuch preparation, it cannot be doubted, but that where proper attention is paid to the conducting of the proceſs and the method of management afterwards, it muſt be highly beneficial, and probably the beſt that can be adopted. It has indeed been lately remarked, that "when the huſbandry that ſucceeds paring and burning is judicious, no mode of improvement can be compared with it; *for it is certain to produce great crops of turnips and grain, and theſe are certain means of future fertility in the hands of a judicious farmer* *."

In addition to this, it is likewiſe obſerved, that ſuch kinds of land, when they are returned again to the ſtate of graſs after having undergone the proceſſes of paring and burning, generally produce not only a much leſs coarſe, but more ſweet and plentiful herbage †.

But notwithſtanding the great advantages that evidently reſult from the operations of paring and burning on ſuch kinds of land as have been already deſcribed, it is probable that by adopting better ſorts of management in reſpect to the modes of cropping in thoſe that have been under tillage, as by alternating green crops of ſome ſort or other with thoſe of the grain kinds, and the full practice of the convertible huſbandry, or that of laying them down to graſs in a proper manner, and at ſufficiently early periods after they have been converted to the purpoſe of growing grain, the neceſſity of having recourſe to ſuch practices may in a great meaſure be obviated. Indeed it has been well

* See Agricultural Survey of the North Riding of Yorkſhire, p. 22.

† See Experienced Farmer, vol. II. p. 8.

remarked by an intelligent writer, that whenever clean-fallows and ſuitable fallow-crops ſhall have been introduced and properly interpoſed between thoſe of the grain kind, as is the practice of the moſt correct modern cultivators, *burning-beat* will certainly be no longer requiſite *.

In ſhort, the neceſſity of employing theſe methods in the breaking-up of ſuch graſs lands as have been already in the ſtate of tillage, would ſeem in ſome reſpect to ariſe from their being kept under the graſs ſyſtem too long; as by that means, in many ſituations, their produce becomes coarſe, and the ſward ſo tough and matted as to be incapable of being broken up, or reduced by the other modes of cultivation. This is ſhewn more fully by the obſervation, that in ſuch lands as are cultivated in the moſt advantageous manner in reſpect to their becoming productive, as by the alternate courſes of grain and graſs, the operations of paring and burning, if not wholly impoſſible, are at leaſt extremely difficult to be performed, as the ſward or turf of ſuch grounds, from their being clean, and laid down in a proper condition, is moſtly ſo tender as not to be capable of being kept together in order to undergo the proceſſes†.

From what has been advanced, it is obvious that in performing the proceſſes of paring and burning care ſhould be taken that the burning be not carried ſo far as to prove injurious by the conſumption of the vegetable materials in the lighter ſorts of land, or by rendering the earthy matters too hard in the clayey ſoils, by permitting the ſod to become too dry before the burning is begun. The more the latter proceſs can be conducted in a ſmothering manner the better, ſo that the fire acts upon the whole. The thickneſs of the turfs ſhould be regulated by the ſtate of the ſward and nature of the vegetables by which it is covered; the aſhes being immediately after the burning ſpread out equally over the whole of the ſurface, and very lightly ploughed or harrowed in; corn and green crops, according to the nature of the land, being then cultivated in proper rotation, and returns of manure, in proportion to the abundance of the crops that may be produced, made to the lands, the whole in due time being laid down to the ſtate of graſs. By theſe means the danger of exhauſting the lands will not only be avoided, but great improvement in many inſtances be effected.

* See Marſhall's Rural Economy of the Weſt of England, vol. I. p. 149.

† See Modern Agriculture, vol. III. p. 397.

PARING PLOUGH FOR ROUGH LAND.

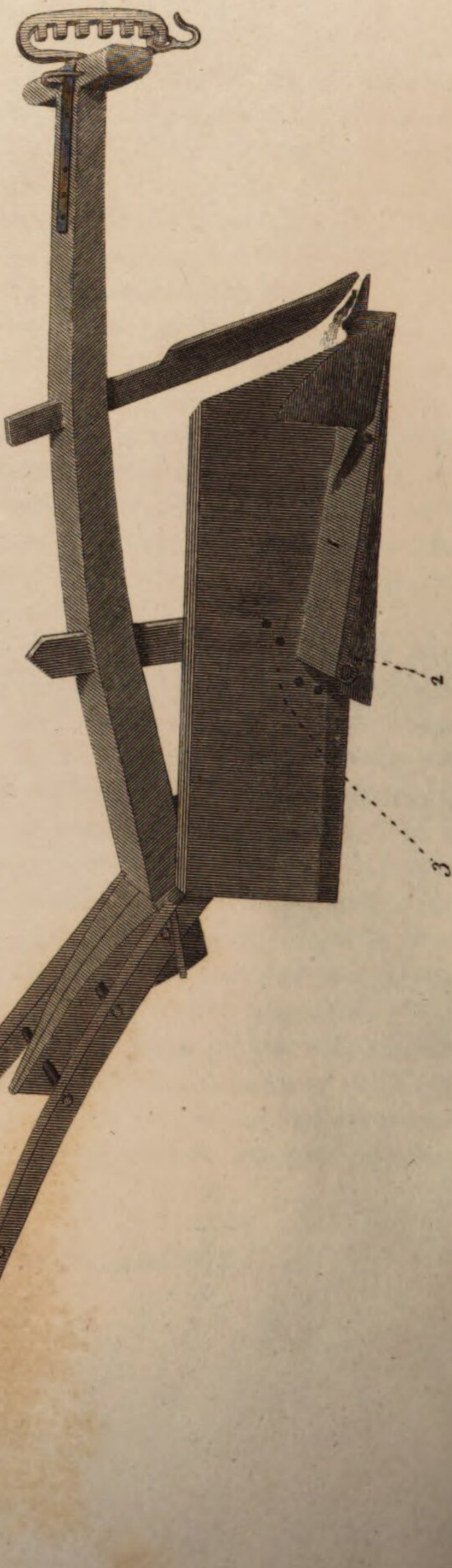


PLATE L.

Paring Plough for Rough Land.

[*To face Page* 356.]

In this plate are two ſide views of a paring plough, given by Mr. Young, for coarſe rough land. The ſhare is ſix inches in width, and riſes or ſinks by means of pivot 2, which ſcrews into the holes 3. It is a highly uſeful implement, being capable of performing its work in caſes where the fen-paring plough cannot ſtir at all. It was in uſe at Sheffield Place, the ſeat of the Right Hon. Lord Sheffield, P.B.A. thirty years ago, having been procured from Cheſhire, where it had been employed on the farm of Sir George Warren.

SECTION X.

Fallowing of Land.

Fallowing—In preparing Lands by Means of, various Changes take place in the Substances that form Soils—A high Degree of Mellowneſs and Pulveriſation moſtly effected by it—By ſuch Means the different Materials become more uniformly and extenſively blended together—Advantages of this in the Growth of Crops—Dews and Moiſture more readily admitted thereby—Deſtruction of Weeds in, alſo uſeful in improving the Soils—Other Modes in which Pulveriſation may be beneficial—By admitting the atmoſpheric Air more abundantly into the Interſtices of the Soils—By the Formation of carbonic or other Acids in Conſequence of it—Of nitrous Acid—Of fluid carbonic Acid—Of Ammonia, or volatile Alkali—The Practice of Fallowing, in theſe Ways, more extenſively beneficial than has been ſuppoſed—Is more adapted to ſome Sorts of Land than others—In ſome unneceſſary or injurious—On the lighter and more dry Soils—On ſuch as are rich from the Applications of Manures—Manner in which it proves hurtful in each—Uſeful in the wet, ſtiff, and tenacious clayey Soils in various Ways—By the Pulveriſation thus afforded the Roots of Plants are admitted more freely—By permitting atmoſpheric Air to enter more fully into the Cavities of the Soils the Matters that promote Vegetation are more extenſively produced—The Roots of Plants allowed to penetrate and take them up more freely by the great Increaſe of Surface that thus takes place—The Deſtruction of Weeds more effectual in this Way—Can only perhaps be effected in wet Soils by Summer Fallowing—Ploughing them in Winter often renders them more ſtiff and adheſive—Dry gravelly Soils may moſtly be managed without this Process; but wet, clayey ones cannot—No Modes of Cropping perhaps fully effectual in the latter—On ſuch Soils they will not therefore obviate the occaſional Uſe of Summer Fallowing—May ſometimes leſſen the Neceſſity of its being employed—Without this Proceſs many uſeful Products could not probably be formed in the Soils, ſo as to promote Vegetation—Green Crops are however neceſſary to be cultivated as much as poſſible with the View of keeping Stock—Sorts of Plants moſt uſeful on, in this Way—Ruta Buga—Cabbages—Beans—Peas—Clover—From the great Varieties in ſuch Soils, Differences in the Uſe, Repetition, and Modes of Fallowing, may be neceſſary—Theſe ſhould be attended to by the Agricultor—Methods of performing it ſhould be varied according to Soil and Circumſtances—Modes of, in different Caſes, deſcribed—How full Pulveriſation may be beſt effected in—Propereſt Times of performing the different Ploughings—Different Methods in which they may be done with the moſt Advantage in reſpect to the Aëration of the Soils—Weeds may be uſefully collected in ſome Caſes—Ploughings aſſerted by ſome to be only neceſſary—Difficult in ſome Caſes to prepare ſtiff Soils in this

Way—Their Cloddineſs prevents the Root Weeds from being deſtroyed—Only effectually deſtroyed by the Pulveriſation of frequent Horrowing and Rolling—Picking off the Weeds ſometimes practiſed after—This Method economical, by rendering fewer Ploughings neceſſary—Froſt more powerful after—Little Danger of ſuch Soils being made too fine—This proved by Experiment—Other Methods of Fallowing that have been recommended too intricate to deſerve the Attention of Farmers—What neceſſary to be regarded in the Application of Manures after, in different Caſes—This ſometimes wholly unneceſſary—Frequently found more uſeful for the ſecond Crop after—Reaſons why the Cultivation of full green Crops may often be more uſeful—Depends probably on ſeveral Cauſes—Summer Fallowing may be much leſſened by this Means—Why they ſeem to improve the Land more than light poor Crops—Land always left more fine and mellow after large green Crops are grown—Hence more advantageous to the Cultivator than naked Fallows—Should be more frequently introduced both on light and heavy Soils—Are admiſſible on the latter more frequently than is in general ſuppoſed by Farmers—How beſt managed on—Obſervations on green Fallows in general.

IN the preparation of land for the reception of grain or other ſorts of crops by repeated ploughings, or the frequent expoſure of new and freſh ſurfaces to the action and influence of the atmoſphere, a variety of alterations and changes are produced in the earthy as well as other kinds of materials that enter into the conſtitution of the ſoils. The heavier or more earthy particles of the land, by being under different circumſtances of the air and ſeaſons thus frequently ſtirred and turned over, are ſo effectually divided or ſeparated from each other, and broken down, that even in moſt of the ſtiffer ſorts of ground, as well as thoſe of the lighter kinds, there is a degree of pulveriſation and mellowneſs effected that could ſcarcely have been induced by any other means; in conſequence of which, the portions of vegetable matter that are preſent, and that may have been reduced into the carbonaceous ſtate, with the calcareous, the argillaceous, and other earthy ingredients, and ſuch metallic ſubſtances as may exiſt in the condition of oxyds or calces, become ſo uniformly and ſo extenſively blended and incorporated, and the manures that are afterwards applied ſo minutely intermixed with them, that the fibrous roots of the growing crops, of whatever nature they may be, are enabled to penetrate and extend themſelves more fully, and of courſe to draw more regular and varied, as well as more abundant, ſupplies of nouriſhment.

Beſides, on account of the extreme diviſion and pulveriſation that takes place, and the great irregularity of ſurface which is produced in this way, the dews and light refreſhing rains that are ſo frequently occurring in the early ſpring months, are more capable of being admitted and diffuſed through and detained in the hollows and interſtices of the ground, and thus to contri-

bute powerfully to the ſupport of the crops in the more incipient ſtages of vegetation.

By the repeated turning-in and deſtruction of different ſorts of plants of the weed kind, much vegetable mucilaginous and ſaccharine matter may alſo be added, as well as the land improved by the putrefactive fermentation that muſt from theſe cauſes be conſtantly taking place.

There are alſo other modes in which advantages may be gained by the repeated turning-over and breaking-down of the particles of ſoils, as from much of the atmoſpheric air being by ſuch methods of huſbandry blended with the fine particles of the ſoils, and detained in the numerous hollows and cavities formed by ſuch degrees of pulveriſation, a larger proportion of oxygen may be ſupplied, which by its union with the carbon and other inflammable materials that are moſtly contained in ſoils, may produce the carbonic or other acids, according to the circumſtances of the caſes, in greater abundance, and in this manner aid the growth of vegetables in a high degree. And as the water or moiſture that is included in large quantities in the pores of ſoils in ſuch powdery ſtates, may undergo the proceſs of decompoſition more fully, by coming more minutely in contact with the portions of atmoſpheric air that are covered up and impriſoned with it in them, the ſupplies of ammonia or volatile alkali, by the combination of its hydrogen with azote, may be more regular and more copious, as well as thoſe of nitre, by the more complete union of its ſuperabundant oxygen with ſome other portion of the abounding nitrogen or azote of ſuch air *.

It has likewiſe been ſuggeſted, that as the atmoſpheric air conſiſts, or is conſtituted of oxygen, azote, and the fluid matter of heat, if the heat that cauſes them to exiſt uncombined in the form of gaſſes be drawn away from them by ſome other material while they are confined in the cavities of the ſoil, they may by their nearer approach to each other combine ſo as to produce nitrous acid; or the oxygen, in its fluid ſtate, not in its aërial one, may more readily unite with carbon, and thus conſtitute a fluid, not an aërial carbonic acid, which is ſuppoſed to be of great utility in promoting the growth of plants. And further, that if any proceſs of the putrefactive kind be going on where atmoſpheric air is in this way confined in the interſtices of the ſoil, and by the deprivation of its heat is converted from a gas to a fluid, the azote may combine with the hydrogen of the decompoſing water, or contribute to decompoſe it, and in this manner form volatile alkali, which, like nitrous acid, may, either during the proceſs of its formation, or after that has been completed, be of very material utility in pro-

* See Darwin's Phytologia, p. 283.

moting vegetation, while at the ſame time the oxygen afforded by the decompoſing water may, like that of the atmoſphere, contribute to the production of the carbonic, nitrous, or phoſphoric acids; and in this way render carbon, phoſphorus, and the baſis of nitre, capable of being taken up by the abſorbent roots of growing plants. From the great diminution of bulk that has been found from experiment to take place where atmoſpheric air is confined in contact with water, it is conceived that there may be a decompoſition of both the water and the air, and a production of both ammonia and nitrous acid, which are known to be beneficial in promoting vegetation *.

In theſe different views the practice of fallowing may in various inſtances be highly beneficial, notwithſtanding the objections that have been ſo repeatedly brought againſt it by writers on huſbandry; but at the ſame time it muſt be admitted that in ſome ſorts of ſoil it will, for ſimilar reaſons, be much more advantageous and uſeful than in others. On the lighter kinds of land, where full and luxuriant crops of different ſorts of plants, as turnips, potatoes, &c. may be grown, that produce a cloſe, thick foliage, and which, as has been ſhewn by experiment †, afford under ſuch circumſtances much carbonic acid, which, from its being greatly heavier than the common air of the atmoſphere, muſt fall upon and be mixed with the ſoil in ſuch ſtagnated ſituations, and thus, together with the more conſtant moiſture that muſt be preſent in ſuch caſes, promote the ſolution and decay of various vegetable matters, and continually add carbonaceous and other materials ſo as to greatly improve the ſoils, it can but ſeldom be neceſſary. Beſides, as in theſe ſoils, by the uſe of the drill, and repeated hand or horſe hoeing during the growth of the crops, the ground may be kept perfectly clean from weeds, and in a fine mellow or powdery ſtate, without the danger of being injured by too much evaporation and expoſure in the way of fallowing; and likewiſe in ſoils of the ſame nature, that are rich from the frequent applications of manure, and in which the proceſſes by which the different nutritious ſubſtances that have been deſcribed are formed and prepared, are properly going on, it muſt be injurious and improper to expoſe their ſurfaces frequently to the influence of the air, ſun, and rain, as is the caſe in fallowing, as by ſuch means the portion of carbonic acid that may exiſt in the ſtate of a fluid, may be made to aſſume the gaſſeous form, and be more readily diſſipated, as alſo the phoſphorus and the other materials in their different conditions before they form nitrous acid or

* See Darwin's Phytologia, p. 284.

† See Prieſtley's and Ingenhouſes's Experiments on Air.

ammonia. Thus, beſides the injury that may be done in fallowing ſuch ſorts of land, by the carbon and other inflammable materials which they contain, combining with the oxygen of the ſurrounding atmoſphere, and afterwards by their further union with other ſubſtances ſo as to form inſoluble compounds, ſuch as phoſphat of lime and calcareous nitre, as has been ingeniouſly ſuggeſted by an intelligent writer *, there may be others of not leſs conſequence ariſing from the diſſipation and loſs of the carbonic or nitrous acid, or of volatile alkali in the gaſſeous ſtate †.

But in all the wet-bottomed, ſtiff, adheſive, and clayey ſorts of ſoil, which conſtitute a large proportion of the lands of the kingdom, where, from the cloſeneſs of their textures, and the great tenacity of their particles, but a very ſlight, or indeed ſcarcely any degree of pulveriſation has been effected, the practice of ſummer fallowing may often be highly uſeful and advantageous, not only by the great mechanical alterations that muſt of neceſſity take place in them by the repeated ploughing or turning up of their parts to the influence of the atmoſphere, but by their admitting the particles of the manures that may afterwards be applied, to be blended and incorporated with them in a more minute and extenſive manner; and their becoming ſo perfectly aërated as that the different proceſſes, that have been mentioned, may take place and properly proceed, ſo as to form in them ſuch ſubſtances as have been found of utility in aiding the growth of crops; and which could not poſſibly have been produced without ſuch pulveriſation as is the effect of fallowing.

The degree of friability and mellowneſs that is produced in this way in ſuch ſoils, has alſo other advantages, ſuch as thoſe of admitting the roots of the growing plants to penetrate them with greater facility, and preſenting a more extenſive ſurface for them to draw their nouriſhment from.

And as in lands of theſe kinds there is a conſtant tendency to throw up abundant crops of root and other weeds ‡, it is perhaps only by the frequent turning over of the ſoil, and the tearing of them up by harrowing, as is the caſe in ſummer fallowing, that they can be effectually eradicated and deſtroyed. It is principally in this view that the working of ſuch ſoils in the early ſpring or ſummer months becomes ſo particularly neceſſary; as at the period in which the ſeed is to be put into the ground, neither the ſeaſon nor the ſtate of the weather

* See Dundonald on the Connection of Agriculture with Chemiſtry.

† See Darwin's Phytologia, p. 288.

‡ See Agricultural Survey of the Weſt Riding of Yorkſhire, p. 81.

will admit of their being ſufficiently broken down and reduced by ploughing, or the weeds to be deſtroyed. And it may be added, that wet lands, by being turned over during the winter ſeaſon, are liable, in many caſes, to become more ſtiff and adheſive, by which the roots of the crops muſt be more limited and confined in their means of acquiring nouriſhment from them.

It has been lately well obſerved, that "when land of a dry, gravelly quality, gets foul, it may eaſily be cleaned without a plain ſummer fallow; as crops, ſuch as turnips, &c. may be ſubſtituted in its place, which, when drilled at proper intervals, admit of being ploughed as often as neceſſary; whereas wet ſoils, which are naturally unfit for carrying ſuch crops, muſt be cleaned and brought into good order by frequent ploughings and harrowings during the ſummer months *." Indeed it is ſtrenuouſly contended by the ſame author, that the moſt judicious intermixture of crops upon clay ſoils will not preclude the neceſſity of a ſummer fallow; though he admits that it may go a great way in preventing the neceſſity of its being ſo frequently repeated †. But another writer, whoſe experience has been conſiderable, while he allows that there is no queſtion at all of the merit of fallowing when compared with bad courſes of crops, and who thinks, that if the huſbandry is not correct in this reſpect, the fallowiſt will certainly be a much better farmer than his neighbours, contends that there are courſes which will clean the fouleſt land as well as any ſummer fallow, by means of plants which admit all the tillage of ſuch a fallow. "Cabbages," ſays he, "are not planted before June or July: winter tares admit of three months' tillage, if tillage be wanted. Beans, well cultivated, will preſerve land clean, which has been cleaned by cabbages; and in any caſe two ſucceſſive hoeing crops are," he thinks, "effective in giving poſitive cleanneſs. Theſe obſervations are not," he ſays, "theory; they are practice: and it is high time that mankind ſhould be well perſuaded, that the right quantity of cattle and ſheep cannot be kept on a farm, if the fallows of the old ſyſtem are not made to contribute to their ſupport ‡."

There is probably, however, many ſituations of clayey ſoils ſo exceedingly ſtiff and wet, that though turnips, cabbage, or bean crops may be grown upon them, it cannot, from the great labour and difficulty of their preparation, and the high degree of injury that muſt be done in the eating or carrying them off the land, be to much advantage, or ſuch as to admit of that ſort of culture during their growth that will keep the ground perfectly clean from weeds. In

* See Brown's Agricultural Report of the Weſt Riding of Yorkſhire, p. 81.

† See Young's Agricultural Survey of the County of Suffolk. ‡ Ibid.

ſuch caſes no courſe of cropping, however judicious, can probably be effectual in this reſpect: it is indeed well known to ſuch practical farmers as have had the management of ſoils of this nature, that it is ſcarcely poſſible to be effected even by ſummer fallowing itſelf. It has alſo been juſtly obſerved, that ſoils of this deſcription are ſo frequently from neceſſity ploughed over when wet, that an adheſion and ſourneſs is produced that cannot be removed without expoſure to the heat of the ſummer's ſun, and the pulveriſation afforded by the repeated operations of the plough and the harrow. There is no ſort of crop that can in ſuch caſes ſupply the place of fallow, as turnips are highly detrimental; and drilled beans, though they may anſwer in the way of an aſſiſtant to fallow, and have the tendency of keeping lands clean that are already in a proper condition, it is ſuppoſed, from the neceſſity there is of ſowing them early, that they can never be beneficially ſuſtituted for the radical improvement that is produced by a clean ſummer fallow *.

But even if ſuch ſorts of land could be kept perfectly clean and free from weeds by the judicious interpoſition of bean, cabbage, or other ſimilar crops that might be cultivated on them, it is evident that the various beneficial products which have been mentioned, and which are the reſult, in a great meaſure, of the perfect pulveriſation and high degree of aëration that is produced by means of ſummer fallowing, could never be formed in ſuch an abundant manner as to be of much utility in aiding the growth of crops. Nor could they be in ſo ſuitable a condition for the admiſſion and extenſion of the abſorbent roots of the plants that may be cultivated upon them.

Yet though theſe circumſtances may demonſtrate the practice of fallowing to be occaſionally neceſſary and highly uſeful on ſuch wet, adheſive, clayey ſoils; as the proper and moſt advantageous quantity of ſtock for the improvement of ſuch farms can ſeldom be kept where it greatly prevails, the repetition of the practice ſhould, in this view, be prevented as much as poſſible, by the cultivation and growth of green crops as often as the lands may be in a ſtate fit for them, and they can be had recourſe to with any chance of ſucceſs. The *Ruta Baga*, or Swediſh turnip, as being a plant ſomewhat more adapted to wet, ſtiff ſoils, than either the common cabbage or turnip, might probably in ſuch caſes be advantageouſly ſubſtituted as a green crop, and by being eaten off in the later ſpring months, when the ground became ſufficiently dry to bear the cattle or ſheep without injury, admit of a pea crop: after which the land would proba-

* See Brown's Agricultural Survey of the Weſt Riding of Yorkſhire, p. 88.

bly be in a ſuitable condition for wheat; or a crop of clover might be taken, and then wheat. But in all ſuch caſes much muſt depend upon the degree of cleanneſs, pulveriſation, and aëration, that has been accompliſhed by the occaſional uſe of ſummer fallowing.

As there is much variety in the conditions of ſuch ſoils as may occaſionally require the aid of naked or ſummer fallowing, in order to render them ſuitable for the growth of clean grain or other crops; ſome from the nature of their ſituation and the ſub ſoils on which they are placed, being more inclined to the retention of injurious moiſture or wetneſs than others, conſequently more diſpoſed to be cold, and to the throwing up of large crops of weeds; while others, from the large proportion of clayey or tenacious loamy materials that may be mixed and incorporated with the pebbly or other ingredients, may be more ſtiff and retentive, and of courſe more difficult or more incapable of ſufficient pulveriſation, and of admitting the roots of ſuch plants as are capable of being cultivated upon them, to readily eſtabliſh themſelves and draw from them proper ſupplies of nouriſhment. And beſides the varieties of theſe different ſtates, there may probably be others that have not hitherto been well aſcertained or attended to, ſuch as may proceed from the differences in the qualities or properties of the clays or loams as they enter into or exiſt in their compoſitions; upon each of which ſome diverſity in reſpect to the neceſſity, repetition, or method of conducting the buſineſs of fallowing, may depend. The correct agricultor ſhould therefore conſtantly keep them in view, whenever it may be requiſite for him to prepare land by means of ſummer fallowing.

In regard to the method of performing the operation, it ſhould always, like moſt other proceſſes in huſbandry, be conducted with a due attention to the circumſtances and qualities of the ſoil, as more pulveriſation or breaking down will evidently be required where the land approaches to the nature of a perfect clay, than where it has more of the loamy quality; and where the retention of moiſture is conſiderable, more regard will be neceſſary to the deſtruction of weeds, than where there is a greater tendency to dryneſs. In moſt caſes where the practice of naked fallowing is thought neceſſary to be performed, the moſt general method of proceeding is, for the land to be firſt ploughed up in autumn, a ſecond time after the barley ſeed-ſeaſon is finiſhed, and two or three times or oftener afterwards, as circumſtances may render neceſſary; the ground being well broken and reduced by means of harrowing in the intervals of the different ploughings. But it has been obſerved, that "in many diſtricts ſeldom more than three ploughings are given to lands in a courſe of ſummer fallow; one in

autumn, or early in ſpring; another during the ſummer; and afterwards the ſeed-furrow. This preparation appears, however, it is further ſaid, extremely defective; as in an ordinary ſeaſon it is ſcarcely poſſible that with ſo few ploughings either the root or ſeed weeds can be completely deſtroyed; and when the ſummer happens to be wet or rainy, the lands under ſuch management muſt certainly be in a very bad ſtate for receiving the ſeed *.

It has likewiſe been long ſince judiciouſly recommended, both in the preparation of lands by winter fallowing for barley crops, and ſummer fallowing for thoſe of wheat, that when it is firſt ploughed up after the harveſt is over (which ſhould always be done as deep as poſſible), no time ſhould be loſt in rendering the new-turned-up ſoil as fine as poſſible by harrowing; as repeated trials and attentive obſervation have fully ſhewn, that ſuch lands as are made fine before the ſharp froſt and winter rains come on, receive a much larger ſhare of their influence than any others. But that if the land be left in a rough ſtate, there is ſeldom time for the rains and froſt to penetrate or affect more than merely the outſide of the large clods or lumps that are preſent. The outſide may thus, indeed, be pulveriſed; but the middle of the lumps, wherever they are large, are found nearly in the ſame hard, ſtiff ſtate, as when turned up by the plough. Hence it is evident that the benefit of the air, winter rains, and froſts, on lands thus left, muſt be only partial; and that of courſe the harrowing it in the ſpring, eſpecially when the latter of theſe are over, is too late for its receiving the full benefits which might otherwiſe have accrued from them, and the power of promoting vegetation not being nearly ſo great. Therefore to make winter fallows as fine as poſſible in autumn, and then ridge them up in that pulveriſed ſtate, is acting moſt agreeably to nature; the greateſt poſſible quantity of ſurface being thereby expoſed to the atmoſphere, and the land left in the ſtate wherein the rains and the froſts are moſt eaſily admiſſible: they are conſequently more capable of penetrating and enriching the whole maſs to a much greater extent.

By this means too, a larger proportion of atmoſpheric air is involved and incorporated with the mold, and of courſe a more perfect degree of aëration effected. It is contended, that it has been invariably found that the froſt penetrates a quantity of earth, formed into a large hard clod, only partially, on account of its bulk and hardneſs, and that the ſame clod, broken into four parts, would be thereby penetrated four times as much; or, in other words, that four

* See Donaldſon's Modern Agriculture.

times the quantity of earth would be affected, and on a thaw be pulverised by it. For it is always found, after the breaking up of a severe frost, that all the small clods crumble easily into powder, while the large ones are only slightly reduced by the crumbling off of a portion of their external surfaces *.

There cannot be much doubt but that by reducing such stiff, adhesive soils, as require fallowing, well on their being first ploughed up, great advantages in the way of pulverisation may be accomplished, as in the spring and summer months they are apt to cake, and become so hard and lumpy as to be wrought with difficulty.

In order to fully ascertain the utility of this method of preparing fallows, one half of a field of ten acres was left as nearly of an equal quality as possible, in the rough state after ploughing; while the other was made very fine, by harrowing and beating in pieces any large hard clods which the harrows could not reduce. In the following spring it was observed, that that part which had been harrowed was much finer without any additional working than the other could be rendered by repeated harrowings †.

It is therefore evident, that upon most sorts of stiff, clayey soils, where fallowing becomes necessary, the first ploughings should be given if possible before the commencement of the winter season, and that they should also be well reduced by means of harrowing, in order to promote the decay of such vegetable matters as may be upon the surface of the land, as well as to promote a more complete state of pulverisation and aëration of the soil. This is often most usefully performed by gathering up the ridges, as in that way the ground is not only laid more dry, but the furrows more effectually opened for the draining off of the injurious moisture. In the second ploughing in the spring, which is generally before the cross-ploughing is given, these ridges ought to be cloven or turned back again, and, after laying a suitable length of time, be well harrowed for several times, and occasionally rolled, that sufficient opportunity may be given to collect and remove every sort of weed that may be brought up to the surface. After this business has been properly performed, the land may be again ridged up by means of the plough, by which it is rendered less affected by wetness, and the portions of soil that had not been touched in the cross-ploughing stirred. In this way a perfectly clean fallow may soon be produced. It has, however, been maintained by some writers who have had much opportunity of examining the matter, that ploughing only is necessary; the collecting the roots of the weeds and removing them being useless and im-

* See Letters and Papers of the Bath Agricultural Society, vol. II. † Ibid.

proper. But in the ſtiffer ſorts of clayey, wet ſoils, where we have conceived the fallowing ſyſtem to be chiefly occaſionally neceſſary, it is almoſt impoſſible to get perfectly clear of different ſorts of root weeds in this way, from the cloddy manner in which ſuch lands break up in the operation of the different ploughings, the earthy lumps often containing many that are not in the leaſt degree injured in their power of taking root, by the heat to which they may have been expoſed in ſuch ploughings. In theſe caſes, they can only perhaps be effectually eradicated and deſtroyed by the high degree of pulveriſation that may be accompliſhed by means of frequent harrowings and rollings; the weeds being afterwards carefully removed by the hand*. In this way there may alſo frequently be a conſiderable ſaving of expence by the leſſening of the number of ploughings. The froſt in the winter months has alſo, as has been ſeen, a much more powerful action where ſuch reductions in the clods of ſuch ſoils have been effected. In ſuch ſoils there can ſeldom be any danger of their being made too fine by operations of this nature, as the ſeed furrow, when given ſufficiently deep, conſtantly leaves the land lumpy and irregular enough for the purpoſes of covering the grain and protecting the young plants during the ſeverity of the winter ſeaſon †. The benefits of affording as high a degree of pulveriſation or fineneſs as poſſible to the land in the management of this proceſs, has been fully ſhewn by the reſults of well-conducted experiments. The produce of a field of barley and broad clover, one half of which had been prepared in the moſt perfect mode of fallowing, and the other half in the common method, on being harveſted and kept ſeparate, was in the following proportions: That which had been conducted in the latter way only affording twenty-four buſhels to the acre, while the former yielded thirty-one, and the grain conſiderably better in quality. There was alſo an equal ſuperiority in the clover crop the ſucceeding year, that on the moſt perfectly-prepared part being heavier by nearly half a ton on the acre ‡. In addition to this, it cannot have eſcaped obſervation, that in large fields of wheat, where from accident or other cauſes ſome portions of them have received more frequent ploughings than others, that in theſe parts

* As it is difficult in ſome inſtances to get quit of the weeds and other traſh that may have been brought together by this means, it is probable, that by mixing cauſtic or quick lime with them, when it can be readily procured, in the proportion of three or four buſhels to ten or twelve of the weeds, frequently turning them over till perfectly reduced, and afterwards adding earth and dung, a good compoſt might be formed.

† See Agricultural Report of the Weſt Riding of Yorkſhire.

‡ See Letters and Papers of the Bath Agricultural Society, vol. II.

the crops generally appear for a great length of time more perfect and promiſing than on the other parts.

But beſides theſe, other methods, eſpecially in ploughing up uncultivated lands with a view to fallowing and rendering them more regular and proper for cultivation, have been propoſed by writers on huſbandry; but they are either ſo imperfectly repreſented as ſcarcely to be comprehended, or of ſuch difficult execution as not to deſerve the notice of the practical agricultor.

In caſes where manure is neceſſary to be applied to land after it has been prepared by the proceſs of ſummer fallowing, it ſhould be done according to the nature of the manure and the circumſtances of land in reſpect to richneſs and the ſtate of its tillage. Lime or marle are generally laid on with the greateſt benefit during the ſummer months, as about the middle of July or the beginning of Auguſt; in which caſes it ſhould be ſpread out as equally as poſſible over the land, and ploughed in with a very ſlight furrow, ſo as only juſt to mix and incorporate it with the mold; as by this means, where farm-yard manure is applied at the time the ſeed furrow is given, in a ſimilar manner, the calcareous and vegetable manures, by being thus more uniformly blended with the ſoil, as well as by their more extenſive operation on each other, afford more abundant and regular ſupplies of nouriſhment to the crops during the firſt ſtages of their growth, and a degree of heat may be generated that is highly favourable to ſuch ſtates of vegetation. That ſome advantage is afforded in this way is evident, from the rapid growth and great verdure that generally takes place where fallows have been managed in this manner.

In ſome caſes of land after fallowing the application of manure may, however, be wholly unneceſſary, as from the great deſtruction of weeds, and the advantages produced in the different ways that have been mentioned, ſuch improvement may be given as to endanger the firſt crop by rendering it too luxuriant, and conſequently liable to be lodged before it becomes ripe, if manure be applied the ſame ſeaſon. Very ſtrong crops of grain have, indeed, frequently been produced on fallowed lands without the ſmalleſt quantity of manure having been put upon them*. Further, it has been aſſerted, that even lands that have been conſiderably exhauſted by improper cropping, have been found to afford a much better crop in conſequence of a fallow, without the application of any dung, than from a complete dunging without a fallow†.

* See Agricultural Survey of Mid-Lothian.

† See Communications to the Board of Agriculture, vol. II.

In ſuch inſtances, therefore, it will be more economical and advantageous to make uſe of the dung with a view to the ſecond crop that may be cultivated on the land, and not that which immediately follows the fallow.

Though the advantages that have been ſtated to ariſe from the perfect pulveriſation, aëration, and cleanneſs, occaſioned by ſummer fallowing, in thoſe ſoils where it has been found to be occaſionally requiſite, can ſeldom be ſo fully obtained by other methods of cultivation; yet as that method is conſtantly attended with a heavy expence to the farmer, and as many of the benefits that are produced by it may be effected by the repeated partial fallowings that muſt occur in the hoe-culture of different ſorts of crops, it ſhould be conſtantly the aim of the agricultor, where the climate will admit of it, to leſſen the neceſſity of ſummer fallowing, even on the wet clayey as well as the light kinds of ſoil, by the judicious interpoſition of ſuch ſorts of cloſe, thick, green crops, as can be grown and cultivated on them under the hoe ſyſtem. This is ſtill more neceſſary, on account of the loſs that muſt be ſuſtained from the land often remaining ſuch a great length of time totally unproductive where the fallowing proceſs is going on. It cannot, indeed, be diſputed, but that the practice of ſummer fallowing may be greatly leſſened in many diſtricts by the proper ſubſtituting of green fallows, or what are termed fallow crops, ſuch as beans, peas, cabbages, tares, and rape, for the heavier ſorts of land; and buck-wheat, potatoes, and turnips, for ſuch as are of the lighter kind *. It is likewiſe maintained as a fact, that where large and luxuriant crops of theſe preparatory kinds are grown, thoſe by which they are ſucceeded the following ſeaſon are for the moſt part ſtill larger, ſo that the lands are more improved by large crops than ſuch as are poor. This amelioration or increaſe of fertility has been attributed to different cauſes: as the prevention of evaporation from the ſoil by the ſhade produced by ſuch large crops; the putrefaction of the various vegetable matters, which may be more abundant after ſuch large crops, taking place more completely and more effectually under ſuch circumſtances; and laſtly, to the repeated pulveriſation and aëration that is produced by the different hoeings: but it is probable that advantages may be derived in each of theſe ways, as well as from the carbonic acid or fixed air that is afforded by the ſhaded leaves of the plants being depoſited upon or united with the ſoil. That the melioration in ſuch caſes muſt depend on cauſes of this kind there can be little doubt, as much of the nutri-

* See an intereſting correſpondence on fallowing heavy ſoils, in the Appendix to the fourth volume of Wight's Preſent State of Huſbandry in Scotland.

tious properties of the land muſt obviouſly have been conſumed during the growth of ſuch crops, which muſt have been again reſtored to it by ſome ſuch proceſſes.

But in whatever manner this effect may be produced, as it is conſtantly found that land is in a better condition, and, when turned up, in a more friable and mellow ſtate after ſuch crops as are large, than thoſe that are poor and light; it is of courſe evident, that if ground can be covered with ſuch ſmothering crops of the fallow kind, or thoſe that will admit of frequent pulveriſation by means of the plough or hoe, ſo as to keep it clean and free from the growth of uſeleſs plants, it may be more beneficial to the agricultor, not only for the ſake of the immediate crop, but alſo on account of the increaſe of manure produced by ſuch means, and the advantageous condition of the land for the reception of ſuch crops as may be afterwards cultivated upon it *. In theſe different views, as well as thoſe that have been already mentioned, the introduction of green crops of ſome ſort or other ſhould probably be more frequently attempted on all deſcriptions of ſoils; and it would ſeem probable, that on the ſtiff and heavy kinds of ſoil—from its having been found, that in many well-cultivated diſtricts, by the growing of proper leguminous crops in drills or rows, ſo as to admit of the ground between them being frequently ſtirred, either by means of the plough or the hoe, ſuch kinds of land, after they have been once well cleaned by a ſummer fallow, may be kept perfectly clean and in ſuitable tilth for the production of good grain crops—they may be much more generally had recourſe to than has commonly been the caſe: but on ſuch ſorts of land great attention is neceſſary to introduce ſuch kinds of green crops as are adapted to them, and that as little injury as poſſible be done by the treading of animals in the feeding them upon or taking them from the ground. But as neither the full effects of pulveriſation or aëration, nor the complete deſtruction of root weeds, can in ſome caſes be ſo perfectly obtained by the cultivation of fallow crops as by the making of ſummer fallows, it may be advantageous to the agricultor to have recourſe to them occaſionally with theſe intentions on the heavy and more wet ſorts of land, as well as thoſe that have been injured by improper methods of cropping.

* See Agricultural Survey of the North Riding of Yorkſhire.

SECTION XI.

Cultivation of Arable Land.

CULTIVATION OF ARABLE LANDS---*Conſidered in Regard to thoſe that have not been under the Plough, and ſuch as have been in a State of Tillage—In the firſt Sort many preparatory Operations neceſſary to be performed.*—REMOVAL OF VARIOUS OBSTRUCTIONS TO PLOUGHING—*Stones—Different Kinds of—How beſt performed—Neceſſity of in different Caſes explained—May frequently be converted to uſeful Purpoſes—Land Proprietors ſhould be at Part of the Expence of.*—CLEARING FROM WOOD—*Different according to Circumſtances—How performed in Trees of the Timber Kind—By trenching with the Spade—By the Plough—When the Roots have been ſomewhat removed, a Crop may be taken—Afterwards more effectually cleared—Moſtly a better Practice to do this at firſt—Reaſon of which explained—Manner of in Plants of the ſhrubby Kinds—Different Plants prefer different Sorts of Soil—Broom—Bramble—Furze—Thorn—Dwarf Willow—Soils on which each grows moſt luxuriantly deſcribed—Alteration of, by the Application of ſuitable Subſtances, how advantageous in deſtroying them—Subſtances to be applied in this View—Methods of extirpating them when grown large—The Practice of burning in the furze Kind to be avoided as much as poſſible—Neceſſary to keep ſuch Lands in Tillage till there is Time to fully deſtroy them—When laid down to Graſs, moſt beneficial to be paſtured with Sheep.*—HEATH—*Nature of the Land on which produced—Affords leſs vegetable Matter for Improvement of than other Plants—On this Account leſs friendly to the Growth of uſeful Crops—Practices to be adopted in removing it, and in bringing the Ground into Tillage—By cutting—By paring and burning---By burning only—What neceſſary to be attended to in each—Implements moſt uſeful in cutting it—Lime neceſſary to be applied to in its cauſtic State—In large Proportions—Mr. Young's Opinion of—Manner of doing it—Should be in a fine powdery State, and equally ſpread out—Soon produces beneficial Effects—Methods in which they are effected—Tillage neceſſary after—Caſes in which it may be deſtroyed without breaking up—Modes of cropping on in different Inſtances—Principal Object in, to be laid down to Graſs—Green Crops to be eaten off, eſſentially neceſſary to—Kinds of moſt uſeful in different Caſes—Turning down green Crops ſometimes practiſed on—Not ſo uſeful as feeding them on the Land—Caſes in wbich it may be employed—Should be returned as ſoon as poſſible to Graſs—Other*

Deſcriptions of Land approaching to this—Such as are productive of Ruſhes and other coarſe Plants—Of ant, mole, or other ſorts of Hills—Much Effect produced in the firſt Kind by draining —Utility of paring and burning in—Other Modes ſuggeſted as more advantageous—Mixing the turfy Surface with cauſtic Lime ſuppoſed a leſs waſteful Plan—Reaſon why it may in ſome Caſes be uſefully employed—Ant-Hills may be mixed in the ſame Way—Proportion of Lime ſhould not be too great—Method of by the Flay-Plough ſometimes very uſeful.—STIFF, WET, CLAYEY SOILS—*Modes of Tillage in—Deep ſtirring often neceſſary—This often effected by the Miner—Doctor Anderſon's Opinion of its Utility—Manner in which it drains the Land—Other Modes of accompliſhing it deſcribed—Manner of rendering ſuch Soils mellow and fine by Lime—The Neceſſity of paring and burning leſſened in this Way—Paring and burning muſt be employed in old, tough Swards, abounding with rough Plants—Repeated ploughing frequently neceſſary in breaking up Waſtes—Different Intentions of—Nature of Soil, Climate, Kind of Crop, and Method of ſowing to be conſidered in—Manner of levelling the Land—Implements employed in—Kinds moſt uſeful.*—MANNER OF BRINGING BOGGY LANDS INTO TILLAGE—*Crops moſt proper for.*—DEEP MOSSY SOILS—*Methods of cultivating them—By floating the Moſs—By the Application of Lime without floating—Caſes in which they may be moſt beneficially employed—Methods that have been followed in Scotland mentioned—Method of applying the Lime on—Quantity made uſe of—Manner of ſowing the Crops on—Crops moſt proper to be cultivated on—Cloſe thick green ones moſt ſuitable—Potatoes—Turnips—Rape—Grain Crops—Proper Sort of for—Graſs Seed—Kinds of proper for—Methods of Tillage in deſcribed.*—RIDGES—*What neceſſary to be attended to in forming of—On clayey Soils—On loamy Soils—On marſhy Land—On ſandy and gravelly Soils—On peaty or moſſy Soils—Ridges in moſſy Soils moſtly formed by the Spade—Manner of performing the Work in—May be increaſed in Breadth in deep Soils of this Kind—General Direction of in all Sorts of Soils—North and South the moſt proper—Methods of forming them in hilly Lands—Advantages of in different Caſes deſcribed—Altering Ridges on old cultivated Lands—What neceſſary to be regarded in—Modes of performing in different Inſtances—By the Spade the moſt perfect—By the Plough more expeditious—Mechanical Contrivances diſadvantageous in—Expences of in different Ways—Other Modes of levelling Ridges deſcribed—The Plough ſhould be moſtly employed for.*—PLOUGHING—*Circumſtances to be attended to in performing of—In heavy Soils—In light Soils—Depth of in different Caſes—Frequency of ploughing different according to the Soil—Repeated Stirring in general more neceſſary on the ſtiff and heavy Soils, than thoſe of the lighter Kinds—On Soils long in Tillage generally leſs neceſſary—For drilling Land ſhould always be in a fine State of Tillage—Nature of Crops moſtly directs the Frequency of ploughing Lands—Some Sorts demand more Tillage than others—A fine State of Tilth generally favourable—Tull's Opinion of Tillage in general—Crops liable to be much injured by Weeds, ſhould always have Land well prepared by Tillage—May often be done by the growth of Plants that demand frequent Culture while growing—By ſuch as have large Roots of the tup or knobby Kind—Reaſons why Land in a fine State of Tilth is moſt favourable to Vegetation—Implements of the Plough Kind moſt proper for performing the Buſineſs in different Sorts of Land deſcribed—Suffolk iron Swing-Plough—The Rotheram Plough—Small's Plough—Importance and Advantages of Ploughs being properly*

conſtructed.—HARROWING—*Different Utility of*—*Kinds of Harrows to be employed in different Caſes*—*Manner of being made uſe of in*—*Drags*—*Scufflers*—*Scarrifers*—*Cultivators*—*Fixed Harrows often uſeful in preparing Land*—*Methods of harrowing to cover the Seed in different Caſes deſcribed*—*Proper Seaſon of performing the Buſineſs in different Soils*—*Particular Manner of accompliſhing the Work in wet, poachy Soils*—*Diſadvantage of this Mode ſtated*—*How performed when Graſs Seeds are ſown.*—ROLLING—*Utility of in different Views*—*In the Way of breaking down the Lumpineſs in heavy Soils*—*In light and porous Soils*—*How it proves uſeful in deſtroying Weeds, and rendering the Land level*—*Kinds of Rollers moſt uſeful for different Purpoſes.*—MANURING OF TILLAGE LANDS—*Intentions of in different Inſtances*—*Kinds of Manure proper for in different Caſes*—*On heavy Soils*—*On thoſe of the middle Sort*—*On marſhy Soils*—*On light Soils*—*On moſſy or peaty Lands*—*Methods of applying with moſt Advantage upon each*—*Nature of the Crop to be attended to in*—*Reaſons of explained.*—*Proper Modes of laying on for particular Sorts of Crops*—*Modes of performing the Buſineſs under different Methods of Culture*—*Manner in which Manures ſhould be chiefly employed*—*Depths to which depoſited*—*Quantities in which made uſe of*—*Seaſons in which beſt applied*—*Sheep-folding*—*Modes of performing it*—*Where moſt uſeful in this View*—*Green Crops*—*Utility of in this Way.*—SOWING—*Modes of preparing the Seed*—*Neceſſity of in different Views*—*Utility and Advantage of in various Inſtances*—*Change of Seed ſometimes neceſſary*—*Reaſons of*—*Broadcaſt, or what is commonly termed the old Method, deſcribed*—*Where capable of being practiſed with Advantage*—*Other Methods more uſeful in ſome Caſes*—*Drill, row, or what is called the new Method, explained*—*This probably older than the other*—*Where capable of being employed to moſt Benefit*—*What neceſſary in*—*Implements moſt ſuitable for*—*The Advantages of each Method ſhewn*—*Comparative Statements of under different Circumſtances*—*Culture neceſſary in each Method during the Growth of Crops*—*Hoeing*—*Kinds of Implements moſt proper for in different Caſes*—*Weeding*—*Implements proper for.*—ROTATION OF CROPS—*Importance and Utility of*—*Thoſe moſt proper in different Sorts of Soils.*—CROPS—*Particular Methods of cultivating various Sorts of*—*Wheat*—*Rye*—*Barley*—*Oats*—*Beans*—*Peas*—*Potatoes*—*Turnips*—*Cabbages*—*Carrots*—*Parſnips*—*Cole or Rape*—*Hemp*—*Flax*—*Methods of harveſting, ſtacking, managing, and preſerving the various Kinds of*—*Manner of threſhing them out*—*By the Flail*—*By the Threſhing Machine*—*Advantages of each Method.*—ARATION—*Lands moſt proper for explained*—*Laying them down to Graſs*—*Beſt Mode of doing it in different Caſes ſhewn*—*Should always be in a fine State of Tilth for*—*Modes of Preparation neceſſary for*—*Graſſes moſt ſuitable to in different Caſes of.*—GRASS CROPS—*Of the artificial Kinds*—*Proper Culture of thoſe raiſed by the Plough*—*Clavers*—*Trefoil*—*Saintfoin*—*Lucern*—*Tares*—*Vetches*—*Checony, &c.*

IN explaining the methods of management that are neceſſary in the cultivation of arable lands, in order to afford a ſuitable ſtate of ſoil and nouriſhment for the growth of grain or other crops, it will be proper to conſider them as relating to

grounds that have not yet been brought under the plough, and ſuch as have been already in the ſtate of tillage.

Removing obſtructions to tillage.—In the firſt there are frequently various operations to be performed, ſuch as the removing of ſtones, the eradicating of wood, both of the tree and ſhrub kind, the deſtruction of different ſorts of plants of the aquatic and other denominations, and the removal of ſuch degrees of wetneſs as may be injurious, before the buſineſs of ploughing or looſening the mold of the ſoil can be properly carried on. The ſtones that oppoſe obſtruction, in this view, are principally either ſuch as are met with in a looſe ſtate in the ground on its being ploughed, or ſuch as are fixed in the ſoil, and incapable of being removed without much labour and difficulty. Some of theſe laſt are often of ſuch a ſize as to preſent themſelves upon the ſurface, and cauſe much land to be loſt, by their not permitting the plough to come near them *. Thoſe which are concealed below the ſurface are, however, the moſt detrimental, as the implements are frequently deſtroyed, and much inconvenience experienced from them, before they can be perceived by the ploughman, though he may be perfectly attentive to the circumſtance.

In ſuch ſoils as contain no concealed ſtones of the rocky kind, as is the caſe in moſt of the alluvial and deep ones, if any inconvenience be ſuſtained by the ſmall ones that appear on the ſurface after harrowing, as may be the caſe at the time of their being ſown with artificial graſſes, or laid down to permanent graſs, from the obſtruction that may be given to the ſcythe, in ſuch inſtances they may be picked off by the hand before rolling; or forcing them into the ſoil by heavy rolling alone, may occaſionally be ſufficient. When the former practice is adopted, they ſhould not, however, as is the cuſtom in many diſtricts, be collected into heaps, or laid all along in the furrows; as in theſe ways they are afterwards liable to afford much obſtruction, or to become again diſperſed over the land. They ought always to be completely removed: the beſt ſeaſon for doing which is, when the land is in ſummer tillage; as under ſuch circumſtances the buſineſs can be performed with the greateſt convenience, and in the moſt effectual manner. In lands that are of the more wet kinds, they may, however, be collected into heaps of rather a large ſize, in order to be taken away afterwards during a dry ſeaſon. The buſineſs of picking the ſtones is moſtly performed by women and children, and the lands are cleared in this way with much greater expedition than can eaſily be ſuppoſed. Though an inſtance or two has been men-

* They are termed *fit-faſt* ſtones in ſome counties.

tioned in which injury was ſuppoſed to have been ſuſtained by the removal of the ſmall ſtones from the ground, from the great evaporation of moiſture that muſt neceſſarily take place, and the want of heat and ſhelter for the crops during the early ſtages of their growth, it is probable that much leſs inconvenience will be ſuffered in this way, than from the obſtruction conſtantly afforded by the ſtones in the tillage of the land, and the loſs cauſed by the great extent of ſurface which they occupy in many caſes where they are numerous.

Where the ſtones are faſt in the ground, of a large ſize, and appear above the ſurface of the land, the beſt practice is to dig them completely out of the earth, after they have been blown to pieces by means of gunpowder; but if they be ſmall, it will be unneceſſary to blaſt them, as they may be raiſed, after being dug round, without that expence, by ſplitting them by means of wedges, or breaking them by large heavy hammers, and then conveying them off the land in ſome kind of low, ſtrong carriage *. In clearing fields of large ſtones, a machine has lately been recommended, by which the heavy expence of boring and powder, with the trouble and danger of blaſting, is not only ſaved, but the labour of loading them conſiderably leſſened. Three men, by means of it, being capable of raiſing ſtones to the proper height with more eaſe, expedition, and ſafety, than ten in the common method. It is formed in the manner of a triangle, and has much reſemblance to that employed by wood-cutters in weighing bark †.

* A ſmall portion of quick lime in fine powder, mixed with gunpowder, is ſaid to have been found to leſſen the expence of that article in blaſting-ſtones.

† It conſiſts, according to the author of the Agricultural Report of Perthſhire, of three legs, made of any ſort of hard wood, each about four inches in thickneſs, ſix inches in breadth, and fourteen feet in length; their thinneſt ſides being placed inwards, to give them greater ſtrength. Their feet, when placed on the ground, form an equilateral triangle, and their three tops being fixed together by an iron bolt that paſſes through each of them; two of the legs are faſtened to each other by a windlaſs and three croſs bars. It has two pulleys, with an iron hook two inches in circumference attached to each, and one or more iron chain to paſs round the ſtone while on the ground, below its greateſt diameter, or where it begins to become narrow; this conſiſts of rounded links about three inches long, and of the thickneſs of a man's little finger, with a hook at one end that may be put into any of the links towards the other end, in order that it may embrace the ſtone exactly, and be of the ſame circumference when the ſtone touches the earth. Short chains of the ſame kind, the hooks of which are fixed into the links of the ſurrounding chain, are to be attached all round the ſtone, with their correſponding links fixed on the hook of the lower pulley. The whole of the rope muſt be of the ſame thickneſs with the two great hooks, two inches in circumference.

The machine being thus prepared, two men, by turning the handles of the windlaſs round, and the

The method of ſinking large pits cloſe to the ſtones for concealing them in, is an expedient that ought but ſeldom to be adopted, on account of the danger that attends it, and the total loſs of the ſtone.

But where the ſtones are principally concealed below the ſurface, it will be neceſſary to diſcover their ſituation, either by going over the land with ſome ſort of ſharp inſtrument that can be readily thruſt down into the ground, or to mark their ſituations during the time of ploughing, and afterwards to remove them by digging. In ſome caſes, as where the ſtones are extremely numerous and the price of labour cheap, it may be a more advantageous and economical method to prepare the land by means of the ſpade than the plough *.

In all caſes, land ſhould be as much as poſſible cleared from ſuch ſtones as retard or prevent the operation of the plough before the buſineſs of tillage be undertaken; as without due attention in this reſpect, conſiderable loſs may be ſuſtained by the breaking of implements, and the great delay that muſt take place in the work.

Beſides, in many ſituations and circumſtances, there may be great inducements to have this ſort of work performed; as where hollow or under-draining becomes neceſſary, the rounder ſorts of ſtones may be beneficially employed in filling them, while thoſe that are of a larger and more flat form may be made uſe of in the conſtruction of offices or other buildings, and ſometimes even for the purpoſe of fences. As this work is frequently attended with a heavy expence, it may be proper, where there are no leaſes, or they are of ſhort duration, to have it undertaken jointly between the land-proprietor and the farmer; the former being at the expence of blaſting the ſtones, and the latter at that of their removal from the ground †.

In the clearing of lands from wood, different methods muſt be purſued according to the nature of the wood with which they are covered. Where there are large trees of the timber kind, they ſhould be completely grubbed up at a proper ſeaſon of the year, care being taken that the roots be as much as poſſible removed. In eradicating ſuch trees as have their roots penetrating downwards to ſome depth, as the oak, it may frequently be unneceſſary, after

affiſtance of the carter with a lever, force the ſtone up, and hold it at the proper height to be loaded by backing the carriage under it. By this contrivance ſtones of very great weight, it is ſaid, have been raiſed and removed.

* See Headrick, in Communications to the Board of Agriculture, vol. II.; and Anderſon's Agricultural Report of Aberdeenſhire.

† See Gentleman Farmer, p. 59.

the earth has been well removed from about them, to cut more than a few of the ſtrongeſt lateral roots, the reſt giving way by pulling at the top of the tree by means of a rope. But in ſuch as have their roots ſhooting laterally near to the ſurface of the ground, as the elm, the roots muſt be almoſt wholly removed before they can be got up, and the buſineſs of ploughing be properly carried on. In caſes of this ſort, trenching by means of the ſpade, and forcing the roots up by a pick-axe, is recommended by ſome as the moſt effectual method; as in this way the roots are not merely removed, but the land put into the moſt convenient form for future cultivation *. Beſides, when ſuch portions of bruſhwood as may have been collected upon the ſurface of the land have been cut at the ſame time and conſumed with the roots, ſome advantage may be gained in the way of manure, by ſpreading the aſhes over the ground, and in ſome meaſure repay the additional expence that may have been incurred by the trenching. But in moſt caſes, eſpecially where the price of labour is high, we believe the buſineſs may be well enough accompliſhed by a ſtrong plough, with a ſuitable ſtrength of team. After the trees, and as many of the roots of theſe ſhrubby plants as poſſible, have been removed during the time of the firſt ploughing up, the land may be ſown with ſome ſort of crop to which it may be the beſt adapted; and after that has been taken off, be more completely cleared by repeated ploughings and harrowings both lengthways and acroſs the ridges, until the whole are extirpated. Or, when there is time, this may be done before any crop is put into the ſoil; which in many caſes is a method to be preferred, as a good or full crop of any kind can ſeldom be expected till the ground has been perfectly freed from the roots of ſuch trees and plants, on account of their more increaſed tendency, under ſuch circumſtances, to ſhoot up and vegetate afreſh, and thereby injure it by the great ſpace which they occupy, and the ſhade they produce, or where their roots decay in the ſoil, by rendering it too light and open for the growth of moſt ſorts of crops †.

As different ſorts of plants prefer different ſoils—the broom and bramble kind being found to grow with the greateſt luxuriance on ſuch as are of the more dry and ſandy or gravelly qualities; the furze, on ſuch as are dry, but which approach the nature of loam or clay; the thorn kinds, on thoſe that are of a more mellow and leſs adheſive deſcription; and the low willows, on ſuch as poſſeſs conſiderable degrees of moiſture—it may be poſſible in many inſtances to derive great advantages in the removal of ſuch obſtructions to cultivation by the appli-

* See Communications to the Board of Agriculture, vol. II. p. 259.

† See ſection on Paring and Burning.

cation of ſuch manures or other ſubſtances as may produce changes and alterations in the textures or general nature of the ſoils, and thus leſſen their tendency to the production of ſuch plants. In this view, the application of clayey marle, or compoſts with peat-earth and lime, or loamy and clayey earths and lime, farm-yard manure, or compoſts made with it and mold, night-ſoil with good vegetable earth, ſand, and various other materials, according to the circumſtances of the ſoil, the nature of the plants, and the convenience of the ſubſtances in reſpect to their application, may be proper. The removal of ſuperficial moiſture may alſo be uſeful in the ſame way in many caſes.

In caſes where ſuch ſorts of ſhrubs have become of conſiderable ſize, the general method of proceeding is to cut them down as cloſe as poſſible to the ſurface of the ground, and afterwards to dig round them, and grub them up in the manner that the larger trees are cleared. With furze it is ſometimes cuſtomary ſet fire to them, in order to uncover their ſtems before any attempt is made to grub them up; but this is a practice that ought to be as much as poſſible avoided, from the danger that may attend it, and the loſs of the furze, as well as a large portion of the valuable vegetable matter accumulated in many caſes beneath them *.

As it has been found from experience, that ſuch lands as have been attempted to be cleared from bruſhy plants of this kind, eſpecially thoſe of broom and furze, are extremely liable, from the roots and ſeeds that may be left in the ſoil, to have them coming up again in great abundance after they have been laid down to graſs; it ſhould be a practice to keep lands that are much diſpoſed to their production in the ſtate of tillage for ſuch a length of time as may be fully ſufficient, by the various means of cultivation, and the application and blending of lime and other ſuitable manures with them, to have them as completely removed as poſſible; and that when they are reſtored to the ſtate of graſs, to have them paſtured, as much as can be conveniently done, with ſheep †. It has indeed been obſerved by an intelligent writer, that

* It is obſerved by Mr. Headrick, in a valuable paper in the ſecond volume of Communications to the Board of Agriculture, that a very powerful and uſeful implement for this purpoſe is, a ſtrong lever, ſhod with iron, and having the iron ſhoeing bent a little upwards by a gentle curve. The iron extremity ſhould divide into two prongs, with an edged angle, ſimilar to a hammer for drawing nails: ſuch an inſtrument may, he ſays, be thruſt in below a ſhrub of any kind until it ſeizes its tap root, and by the aid of a ſtone or block of wood, to ſerve as a fulcrum, the ſhrub may be rooted out by one effort.

† Sheep, horſes, and even every kind of neat cattle, are extremely fond of the young and tender ſhoots of broom, furze, and other ſorts of plants in the ſpring months, probably from their juices con-

if whins, or ſhrubs of any kind, are once grubbed up in the way that has been deſcribed, ſheep being then admitted to paſture, would prevent them from ever growing again from the ſmall roots left in the ground. But ſtill more would this experiment, he conceives, be likely to prove ſucceſsful, if the ground were completely fallowed, and every root that appeared, removed. The land, being then well limed and manured, might be ſubjected to a courſe of cropping, and be ſown down with graſs ſeeds without a crop. As ſoon as the graſs afforded a ſafe bite, he would admit ſheep, and not wait for a crop of hay. It is preſumed that ſheep would deſtroy the tender ſhoot of every ſhrub as faſt as it roſe, and keep the ground ever after clear*.

If, however, this practice ſhould not be ſufficient to prevent the ſhrubs from ſending up freſh ſhoots, the beſt method would be to have again immediate recourſe to the plough, and ſuch other means as have been recommended above, as by delay the plants may become too ſtrong to be turned under by the plough.

Heath, which is a ſort of plant that for the moſt part infeſts thoſe ſoils that are of a moory nature, and in which there is but a ſmall proportion of vegetable matter, on account of there being few leaves or other vegetable products, except the heath itſelf, to be converted into mold; the recrements of this plant are not found to afford improvements to the ſoil on which it grows, in the way that is experienced to take place from the decay of many other more ſaccharine, mucilaginous, and juicy plants. Hence it probably is that the heathy ſoils are moſtly ſo poor and unfriendly to the growth of uſeful crops, whether of the grain, leguminous, or graſs kinds. In bringing this ſort of land into the ſtate of tillage—as it has been found from repeated trials, that where the heath is turned down without being removed or completely deſtroyed, it keeps the furrow ſlices from coming into intimate contact with each other, ſo as that by confining and retaining a due degree of moiſture, the decompoſition and decay of the heath may be quickly effected, and the ſoil of courſe in too open and looſe a ſtate for the growth of almoſt any crop—it ſhould be cut as cloſe to the ſurface of the ground as it can be conveniently done; or what is probably a better practice,

taining a large proportion of ſaccharine matter during the early ſtages of vegetation. Mr. Headrick indeed aſſerts, that a Scotch acre of whins is worth from 3 to £.5, as winter food for horſes and cows, to thoſe who have a ſtone running upon its edge for bruiſing them, provided the ſhoots are not older than from three to four years, and that there are no impediments to interrupt the ſcythe: hence he draws an inference that, in many caſes, whins are the moſt profitable crop that a ſoil can bear, provided they be duly managed.

* See Headrick, in Communications to the Court of Agriculture, vol. II. p. 262.

removed, by paring off a very thin ſlice of the ſurface ground with it, and then either conſumed by means of fire, or applied to ſuch other purpoſes as may be neceſſary *. In the dry ſpring months it is indeed capable, in many caſes, where it grows high and of conſiderable cloſeneſs, of being burned without the labour and expence of either of theſe operations. But in all caſes where fire is employed, as the ſtaple of ſoils of this kind is ſeldom deep, care ſhould be taken that the combuſtion be not carried to too great a height, ſo as to prove injurious by conſuming the ſmall portion of vegetable material that may be preſent †. The operation of cutting the heath may be moſt conveniently performed by an implement of the ſcythe kind, only made much ſhorter and of greater ſtrength, ſo as not to give way or break by the ſtiffneſs of the ſtems of the plants.

The heath having been removed in ſome of theſe ways, lime in its cauſtic or moſt active ſtate is to be applied in large proportions, either over the whole of the ſurface before the ground is ploughed, or upon the ſoil when turned up. The former method is, however, to be preferred, as coming more intimately in contact with the plants, where lime is ſcarce, and cannot be laid on in large quantities; but where it is plentiful, the employing it in both ways might be more beneficial, by its thus tending more readily to the deſtruction of the roots as well as the ſtems of the plants. Where it can be procured, lime ſhould, however, always be put on in large proportions on firſt bringing heathy or moory ſoils into the ſtate of cultivation, as little ſavings in this reſpect in the firſt inſtance may often prove highly diſadvantageous in the end. It has been obſerved by an able writer, that experience has proved that the addition of lime to the aſhes of the pared ſurface operates greatly more beneficially than if ſpread in any other manner: and that the larger the quantity the greater the effect, and probably the greater the proportional effect; that is, ſix chaldrons an acre will do more than twice the good of three chaldrons; the chemical effect both in neutraliſing the acids found in all theſe ſoils, and alſo in deſtroying the roots left of the ſpontaneous growth, depending in ſome meaſure on the effect taking place ſuddenly. It has been known, that eight chaldrons an acre, laid on at

* It is well remarked by Mr. Headrick, in the paper mentioned above, that long heath makes a moſt excellent thatch for houſes, far more durable than ſtraw of any kind; it alſo makes excellent rinces for ſcrubbing milk veſſels. From its extreme durability, it is alſo the beſt of all ſhrubs for making concealed drains.

† See ſection on Paring and Burning.

once, have converted a moor into meadow worth twenty-five ſhillings an acre; but the ſame moor, under one chaldron per acre per annum for eight years, has not been worth ſeven ſhillings and ſix pence an acre. The effect of lime on all ſoils long in cultivation, is, he thinks, problematical, and does not anſwer the expence in one caſe in ten; but in new moor lands the effect is prodigious and hardly credible: laid on ling mountains without tillage, without paring, or other operation than merely cutting the ling and ſpreading the lime, ſuch moors have been changed from one ſhilling to twenty ſhillings per acre; but the quantity has been fifteen or twenty chaldrons per acre*. The application muſt, however, always be regulated by the circumſtances of the caſe. Where the expence per acre is forty or fifty ſhillings, the improvement will ultimately come high. And in order that the calcareous matter may be as intimately as poſſible blended with the particles of the ſoil, and thereby exert its effects moſt extenſively, it ſhould be applied over the land in the moſt perfect ſtate of pulveriſation, and as equally as it is poſſible to ſpread it out. Where the lime is applied with ſufficient attention to theſe circumſtances, it generally deſtroys the heath in a ſhort time, probably in ſome meaſure by its powers of attracting moiſture from the ſoils, and combining with the acid aſtringent juices of the plant, and rendering them incapable of affording it that kind of ſupport which is requiſite for its healthy growth, as well as by the alteration of texture that is produced in the land, and the cauſtic deſtructive action that may take place in conſequence of its coming into contact with the roots in that ſtate. This is probable from its being found to be the moſt effectual when laid on ſuch lands in the ſtate of quick lime, though ſomething may no doubt depend on the eagerneſs with which moiſture is attracted by it in ſuch caſes. After the lime has been applied, eſpecially where the ſurface has been pared off and conſumed by fire, the ploughing ſhould only be ſlight, ſo as to blend it and the aſhes with the ſoil, but not to place them at a great depth below the ſurface.

Where heathy or moory land has a higher degree of ſurface wetneſs, and is not ſo much overrun with the plant as to prevent its being employed as paſture, it may ſometimes be brought into cultivation by merely removing the ſuperabundant moiſture by proper drains, burning the heath in the ſpring months when ſuitably dry, and afterwards paſturing it cloſely with ſheep ſo as to keep it from ſeeding; as in this way, in time, it in ſome caſes becomes wholly removed†.

* See Young's Annals of Agriculture, vol. XX. p. 369.

† See ſection on the Cultivation of Graſs Land.

When this ſort of ground has been broken down and pulveriſed as much as poſſible by the operations of ploughing and harrowing, it ſhould always, where not too ſtiff, be ſown with ſome ſort of cloſe, luxuriant, green crop, ſuch as turnips, peas, and tares, that may be fed off by ſheep; but where it has a ſour quality, and is more ſtiff, clayey, and adheſive, thoſe plants that ſtrike more deeply into the ſoil, as beans, Swediſh turnips, buck-wheat, rye, and oats of the grey kind. In many caſes too, rape, peas, clover, and vetches, will ſucceed in a very beneficial manner. But as the principal intention in moſt caſes of breaking up this ſort of land, is that of bringing it in a cheap and expeditious manner to a ſuitable condition after a grain crop or two for growing graſs, the green crops, of whatever deſcription they may be, ſhould be conſumed by animals upon the ground, eſpecially where the ſoil is ſuch as to admit them without injury; as in this method a high degree of fertiliſation and improvement may ſpeedily be obtained at little or no expence, from the great benefit the animals receive. If it can be conveniently done, two or more of this ſort of crops may be conſumed on the land in the ſame ſeaſon * with ſtill more beneficial conſequences. Where the ſoil is too wet, ſtiff, and poachy, to admit of this practice, the crops may be drawn, or cut, and converted to the feeding of cattle in the houſe. It has been well obſerved, that proper cropping "is the key-ſtone of the arch;" and that if it be not attended to with great care, the whole of the improvement may turn out diſadvantageous†. There is, however, another method of improving theſe ſoils by ſuch crops, which is that of turning them down, when in their moſt ſucculent ſtates, by the plough. This may be a judicious and uſeful mode on the drier and more ſandy deſcriptions of theſe ſoils, where they may readily undergo putrefaction and decay; but in the more tenacious ſorts, and where there is a ſour diſpoſition that would greatly retard the proceſs, it would ſeem to be much leſs beneficial than that of feeding them off by ſome ſort of live ſtock.

But in whatever method they may be brought into the ſtate of cultivation, the proceſſes of tillage ſhould not be carried further than the deſtruction of the heathy or other coarſe plants, and the removal of the ſour and unfriendly diſpoſition of ſuch ſoils for the growth of uſeful vegetable productions. They ſhould be then reſtored as ſoon as poſſible to the ſtate of graſs or paſture.

There is another deſcription of land, which approaches in ſome degree to

* See Headrick, in Communications to the Board of Agriculture, vol. II. p. 265.

† See Young's Annals of Agriculture, vol. XX. p. 371.

the nature of the above, that in bringing into tillage requires the coarse plants and herbage that it is naturally disposed to produce, to be extirpated and removed, as well as the hills and other inequalities that are sometimes present levelled down and destroyed, before the plough can be properly employed upon it. This is that which, from its moisture, is naturally subject to the growth of rushes and other coarse aquatic plants, and that on which ant, mole, or other sorts of hills have been from long inattention and neglect suffered to accumulate to a large size, to become numerous, and to be covered with a tough sward. In cases of breaking up this kind of coarse grass land for the purpose of tillage, much may be effected where they are very wet, by first forming such concealed or other kinds of drains as may be necessary according to circumstances for carrying away as much of their moisture as possible; as by this means the tendency to throw up crops of these coarse plants may be greatly lessened, while at the same time the land is rendered more proper for the growth of most sorts of grain, or even green root-crops. After this has been as much as possible accomplished, paring and burning may frequently be most beneficially employed, as by these operations the whole of the coarse vegetable products are at once completely reduced and destroyed, while a slight portion of manure is added in the ashes, and the ground is made ready for being ploughed, and the seed being introduced, in the shortest space of time possible; whereas, when the sward is turned down after the coarse plants only have been removed, a considerable length of time is required before it becomes sufficiently rotted down and reduced by putrefaction, for the bearing of good and useful grain or root-crops. There are other views in which this practice may be useful; as by the more effectual pulverisation and aëration of the soil that is produced, which is of great utility in such land, as well as by the more complete destruction of those insects that are so numerous and often so injurious to crops sown on these grounds *. But, instead of the practice of paring and burning, it has been suggested by a late writer as more advantageous, after the turf is cut from the surface of coarse land, which is meant to be reclaimed, to collect it all into heaps in different parts of the field, and make it up into compost with lime. The turfs he recommends to be completely drenched with water at the time the lime is applied; and then frequently turned and champed among it, receiving as much water as they can retain at such periods. By these means they will, he supposes, soon be reduced into a manure of the most excellent quality; all the

* See section on Paring and Burning.

fibrous parts of the plants will be rotted, and converted into ſubſiſtence for the ſupport of new vegetable productions. At the concluſion of the proceſs, as the lime muſt then have loſt moſt of its cauſticity, as much dung, or other putreſcent manure, as can be ſpared, may be mixed with the compoſt. The compoſt, having been thus formed, ſhould be replaced over the whole ſurface of the land as equally as poſſible *.

By reducing the vegetable materials of the ſoils in this way, it is ſuppoſed that there is not any loſs ſuſtained, as is the caſe where fire is employed. But it is evident, that even where the proceſs of decompoſition is effected in the moſt eaſy manner, as by ſuffering ſubſtances to run naturally into putrefaction, there is always a conſiderable eſcape of uſeful elaſtic matters; it can hardly be doubted but that much loſs muſt take place where it is accompliſhed with a degree of violence, as muſt be the caſe where lime in its cauſtic ſtate is combined with green ſucculent vegetable ſubſtances. Beſides, in this mode of practice, the expence of bringing the materials together ſo as to be diſpoſed of in this manner, will often be too great to repay the cultivator; and in ſome ſituations lime cannot be at all procured. As it is, however, as has been already ſeen, a convenient and expeditious method of bringing coarſe, ligneous materials of the vegetable kind into an earthy condition, it may in different inſtances be had recourſe to with beneficial effects. The ſeparation of ant-hills where they are abundant, and blending them with lime in this way, might alſo be an uſeful practice, eſpecially as they often contain much animal matter at certain ſeaſons, and are ſo bulky as not to be diſpoſed of without being removed from their ſituations. In all ſuch caſes, the quantity of lime ſhould only be ſuch as to exert a gentle operation on the vegetable materials with which it is thus combined; as where a large proportion is employed there may not only be a great loſs by its too quickly diſengaging the elaſtic matters from them, but by its reducing ſome of their more fibrous parts into an indiſſoluble coaly ſtate.

There is, however, another method in which land of this kind may be readily brought into the ſtate of cultivation, where the coarſe vegetable matters are not ſtrong or very thick on the ground, as is the caſe in ſome coarſe paſtures. This is that of having a ſharp *flay* or *wing* attached to the plough, ſo as to cut up and depoſit a thin paring of the ſurface or ſward in the bottom of the furrow, which is effectually covered by the furrow-ſlice that is immediately raiſed by it from below †. In this way the land becomes at firſt, after being well harrowed,

* See Communications to the Board of Agriculture, vol. II. p. 206.

† See ſection on Implements.

nearly as fine as by a fallow; and the crop is in leſs danger of being injured by the growth of weeds. A ſtrong team will, however, moſtly be neceſſary in performing this buſineſs, which in ſome inſtances, where the land is ſoft and full of moiſture, may do harm by the treading that takes place.

In damp, ſtiff, clayey, or what are frequently denominated *tilly* ſoils, there is often great labour required in bringing them into the ſtate of tillage. As in theſe caſes too much moiſture is generally retained at a little depth below the ſurface, the ſoil can ſeldom be rendered dry to a ſufficient depth for the growth of good crops. Proper draining ſhould be here firſt attempted; after which the land may be opened up as deep as poſſible by the common plough, having others, ſuch as that which has been termed a *miner*, following in the bottom of the furrow, ſo as to open and looſen the ſoil in a very deep manner, and in that way remove the water to ſuch a depth below as to prevent it from doing much injury to the crop.

It has been well obſerved, that where the earth has only been opened to the depth of a few inches above a ſtiff clay, or other kind of retentive under ſoil, whenever rain comes in large quantities the greateſt part of it muſt be ſoon carried away, or the land will be drowned and rendered unfit for the growth of crops, whatever may be its condition in other reſpects. Hence the neceſſity of the practice of making a ſufficient number of open-furrow drains on ſuch ſoils, for readily and effectually conveying away the ſuperabundant moiſture or wetneſs. This water, it is ſaid, flows partly along the ſurface until it falls into the furrows, and it partly ſinks through the mold till it reaches the open furrow; but, unleſs it be during very heavy daſhes of rain, the greateſt part of the moiſture ſinks gradually through the pervious mold, until it meets with the impervious ſubſtratum that lies below it. When the water reaches that ſubſtratum, it forms a kind of ſubterranean lake, which finds no iſſue, until by its gravity it forces for itſelf a paſſage laterally through the crannies of the mold, till it at laſt reaches the open furrows prepared for that purpoſe, which afford it then a ready outlet, through which it can flow off the ground. In theſe circumſtances it is obvious, that the portion of the mold which lies immediately contiguous to the ſubſtratum, muſt be, for ſome inches in depth, more or leſs in proportion to the quantity of rain, and the tenacity of the ſoil, in a ſtate of bog or watery quag, that is unfit for ſuſtaining any of thoſe plants which it is the aim of the huſbandman to cultivate in this climate. In this ſtate, too, the mold there being ſo long ſoaked in water, and ſo frequently drenched by it, muſt have every material it contains that is ſoluble in water completely waſhed out of it in a very ſhort time, and its

particles ſo frequently and thoroughly ſoaked as to reduce it to a kind of paſte, fitter to be converted into a brick on drying than to become a friable mold. If the earth be looſened by the plough only for a few inches depth on the ſurface of ſuch ſoils, the whole of this paſting proceſs muſt take place among the only mold in which the plants that grow upon it can ſeek their nouriſhment; ſo that this ſoil muſt be at one time in the ſtate of a pap that would be too thin for the mortar in a maſon's tub, and at another time it muſt be as dry, and nearly as hard, as a ſun-made brick. In this condition what ſort of crops, it is aſked, can be expected of any kind? It is this ſort of management which, for the moſt part, is the cauſe of that kind of ſtarved unproductiveneſs of ſoil, which is known among farmers by the name of *hide-bound*, which many men believe it would be throwing away money to attempt to reclaim. And it is certainly true, that ſo long as men ſhall continue the practice of ſuch ſcratching of ploughing as that here taken notice of, they judge rightly. But under the ſyſtem of management above deſcribed, many of theſe ſoils may in time be rendered amongſt the moſt productive in the iſland, and with great profit too to the judicious operator. When the ſoil is opened up by the proceſſes recommended above, it is rendered pervious to water to the whole of the depth to which it is looſened; while at the ſame time the water is allowed to find its way off the ground at a depth ſo far below the ſurface, as not to injure that portion of the mold in which the principal roots of the plants abound. Indeed, a great part of that moiſture, in theſe circumſtances, never finds its way off the ground at all; but ſoaking gradually downwards, that water, which, if it had only been allowed to ſink three inches, muſt ſoon have reached the bottom, and there have been regorged back upon the ſoil, will require at leaſt five times as long a period to ſink to fifteen inches deep, and in its progreſs will be only gradually moiſtening, inſtead of drenching the ſoil; ſo that if the rain ſhall ſubſide before it has reached the bottom, no part of that water will be carried off the field, unleſs what flows over the ſurface; but it will there remain to moiſten the earth only to a ſalutary degree, and, like the water in the ſtomach of a camel, afford a ſupply when drought comes on, and parches the ſurface of the ground: for the deep fibres of the roots penetrating downwards, there will find moiſture, which thoſe near the ſurface would then be deprived of. Thus does the practice recommended operate alike as a cure for the exceſs of wet as of drought, and produces a healthy vegetation in all circumſtances. One would wonder, that ſeeing the effects of this proceſs ſo univerſally in our gardens, to which theſe owe in a great meaſure their ſuperior degree of fertility, men ſhould

ſo ſeldom have adverted to the benefits they would derive from the ſame proceſs being extended to the fields. They ſee, it is further remarked, that in gardens, even where the ſoil is very retentive, good crops are produced without water furrows at all; whereas in fields of the ſame nature they know that nothing of this ſort could be expected *. It has, indeed, been alſo aſſerted, that the above implement has been ſucceſsfully employed to cut out ruts in the bottoms of the furrows, when the land is croſs-ploughed, and alſo to deepen the water-furrows ſo as more effectually to diſcharge the water. Theſe ruts divide the ridges into ſmall chequers, and although they are covered again with the ſoil, they ſtill retain ſuch a degree of openneſs, as to permit water ſlowly to percolate. A rope of ſtraw or hay placed here and there into theſe ruts, converts them into permanent concealed drains †.

It has likewiſe been propoſed in theſe caſes, after the ruſhes or other coarſe vegetables have been cut down and carried away, to throw up two furrow ſlices that have been cut deep by a ſtrong plough againſt each other, ſo as to form a conſiderable elevation in the middle of the ridge, and then with a paring-plough or ſpade to follow the plough, and ſtrip off a ſod of about an inch in thickneſs, and the breadth of a furrow ſlice, which being thrown into the bottom of the furrow previouſly made, with the heathy or ruſhy ſide undermoſt, is to be trod down by a man who follows the ſpade or paring-plough. And that laſtly, the ſtrong plough is to follow the paring-plough, and heave up the earth which it had laid bare to the depth of about a foot, throwing it over upon the ſod previouſly placed in the oppoſite furrow. By this means, it is ſuppoſed, that the ſods compoſed of ſhort heath, ruſhes, or other coarſe herbage, being buried at ſuch a depth below the ſurface, muſt ever after keep the ſoil open, allow the water to percolate, and a great depth of ſoil be at the ſame time obtained. Or, what is conceived might be a ſtill more beneficial method in theſe ſoils, is that of ſcooping or hollowing out ſmall ruts or openings at ſhort regular diſtances, in the bottoms of ſome of the furrows, with the *miner*, or ſome other convenient implement of a ſimilar kind, and then filling them with the heath, ruſhes, or other coarſe materials that may have been cut from the ground, covering the whole with the paring of ſward as before. It is imagined that in this way each would perform the office of a concealed drain, and convey away the exceſſive moiſture at the

* See Anderſon's Eſſays, vol. III. p. 237.

† See Communications to the Board of Agriculture, p. 267.

bottom of the ridge, the ſward or upper covering preventing them from being ſtopped or filled up by the mold. By ſuch means, the moſt obdurate and irreclaimable clay, being kept open below and free from moiſture, may, it is ſaid, ſoon acquire all the properties of a ſoil of the greateſt depth and fertility.* The buſineſs in theſe caſes, though capable of being done by proper implements of the plough kind, is always performed with greater exactneſs by means of the ſpade. But in either way it can probably be advantageouſly had recourſe to only where the price of labour is cheap.

Experiments have ſhewn that waſte ſoils of the moſt obdurate kind, ſuch as conſiſt of thin, moory earth, upon aluminous and pyritical clays of conſiderable depth, fit only for bricks, may be rendered mellow and fertile, by cutting the hard adheſive ſurface ſlices after being ploughed up into pieces, forming them into a kind of walls or dykes in order to their being more fully acted upon by the influence of the atmoſphere; and after they have been thus conſiderably reduced, mixing them into compoſts with lime, and re-applying them, the bare under ſoil being in the mean time well ploughed or wrought with the ſpade, and incorporated with lime †.

In theſe ways the practice of paring and burning may in many caſes be rendered unneceſſary, where the ſward is not too tough and matted, or covered too thickly with coarſe vegetable productions; but wherever there is much toughneſs of the ſurface, or a great abundance of rough plants covering it, there can be little doubt but that the method of paring it off and conſuming it by fire, will be the moſt eaſy, effectual, and expeditious manner of bringing the land into a ſtate of cultivation.

As in the breaking up of waſte lands, whether they be thoſe of the ſtiff and heavy kinds, or ſuch as are of a more light and friable nature, repeated ploughings will frequently be required, not only with a view of reducing the ſward and other parts into a mellow and pulveriſed condition proper for the growth of crops, but to fill up the hollows and inequalities that are generally met with in ſuch lands, in order that they may be laid in a ſuitable manner for the purpoſes of tillage, it will be neceſſary to keep in mind not only the peculiarities of the ſoil and climate, but the kind of crop and the method in which it is to be put into the ground. Thus ſome of the ſtiffer ſorts of ſoil, in a climate where too much rain does not fall, may be much benefited by being expoſed to the influence of the atmoſphere during the winter ſeaſon; while others under

* See Communications to the Board of Agriculture, p. 267. † Ibid. p. 268.

contrary circumſtances may be injured, by being thus rendered more liable to become wet and miry, and on the approach of dry weather ſo hard and compact in their texture as to be improper for the reception and growth of crops; theſe ſhould therefore be ſubjected to the operations of tillage chiefly in the early ſpring months, when the injuries to be apprehended from wetneſs are daily becoming leſs. Where ſome ſorts of grain crops, as wheat and barley, and thoſe of the green kind, ſuch as turnips, potatoes, peas, and many others, are to be cultivated, the land ſhould always be rendered more fine and mellow by theſe means, than where other crops, as oats, &c. are to be grown. And, indeed, wherever the practice of the drill huſbandry is to be purſued in putting in and cultivating crops, it is moſtly advantageous to have the land as ſoon as poſſible brought into a ſtate of as perfect pulveriſation as can be effected; as from the frequent ſtirrings afterwards, under this ſyſtem of management, there is ſeldom any danger of its becoming too hard from being baked by the heat of the ſun.

In managing the buſineſs of levelling the land, as it can ſeldom be effectually performed by the plough, various implements have been conſtructed in order to expedite the work; but as they can rarely be managed with that eaſe and facility that is requiſite for the common labourer, it is probable that the ſpade and common wheelbarrow, or ſingle-horſe cart, when judiciouſly employed, are by much the beſt implements that can be had recourſe to for ſuch work; as by ſuch means the earth can be taken away or depoſited upon thoſe parts where it is moſt wanted, and to the improvement of which it is from its nature and qualities the moſt ſuited; a circumſtance that ought invariably to be attended to, as in this way the more open and porous materials will be laid in the ſtiff and adheſive parts, and ſuch as are more cloſe and compact, on thoſe that are looſe and friable. It is obſerved by Mr. Headrick, in his valuable paper on bringing waſte lands into cultivation, that he has ſeen many levelling machines for reducing inequalities and for ſcooping out ſlope drains, where neceſſary, in a field; but he never ſaw any that did not do infinite miſchief to the land on which they were uſed. They require, ſays he, immenſe force, of courſe every animal that drags them ſinks to the knees at every ſtep, and leaves holes in the ſoil in which water will lodge for ever. They leave no choice of the ſpot, where what is dragged out of one place, is to be depoſited. The neareſt hollow is the ſpot where, right or wrong, the contents of ſuch machines muſt be dropped. Where ſuch machines operate upon deep, loamy, and friable ſoils, they may do no miſchief, though all their effects may be attained in a much more cheap and economical manner;

but he has ſeen ſome land wholly ſpoiled and rendered unproductive by the uſe of ſuch machines.

He alſo ſuggeſts, that by having the barrows to run upon ſtrong coarſe pieces of deal in the way of rails, much advantage may be gained, eſpecially for ſhort diſtances, in the economy of labour; and that ſmall carts or other ſorts of carriages, placed upon low broad wheels or rollers, and drawn by one horſe, might likewiſe be uſeful in accompliſhing this ſort of buſineſs. High carriages, whether carts or waggons, are conſtantly to be avoided for ſuch uſes, as cauſing much unneceſſary exertion, and a great waſte of ſtrength in raiſing the materials.

There is another deſcription of land that is frequently to be brought into the ſtate of tillage, in which the methods that are to be adopted are in ſome reſpects different: this is that of the boggy kind. In theſe, the firſt thing after having them well drained by the cutting of proper ditches—which, where they are large, may ſerve for their incloſure, and by giving the ridges a ſuitable form in order to aid this—is to pare off and level the ſurface by means of the ſpade or plough; ſuch matters as are of little value being depoſited in the hollows, while thoſe that are of a good quality may be mixed into a compoſt with good dung, where it can be procured, or with lime: or if the ſurface materials be very coarſe, it may be more advantageous to conſume them by fire, together with the ſpare earth taken from the ditches; or this earth may be afterwards blended with the aſhes and a little lime: but, in whichever way, they ſhould be immediately ſpread equally over the land, and incorporated as much as poſſible with it, by ploughing it up with a very ſlight or ebb furrow, in order that the uniting materials may not ſink too deep for affording due ſupport to the crop that may be cultivated. Indeed, though deep ploughing may ſometimes be of utility in firſt opening up theſe ſoft ſoils, it ſhould never be had recourſe to when the application of manure is to be made, for the reaſon that has been juſt ſtated; and on this account alſo the ploughings after the taking of different green crops ſhould only be ſlight. Where the ſurface of land of this ſort has not been pared and burned, in moſt caſes more labour and expence will be neceſſary in repeatedly ploughing, in order to bring the ſoil into a proper ſtate for the production of crops. It is ſeldom proper to continue ſoils of this deſcription for any great length of time in the ſtate of tillage, as from their great moiſture, on account of the general flatneſs of their ſituation, and their being liable from continued ploughing to become very looſe and open, ſo as not to afford proper

nouriſhment or ſtability to the roots of the crops, this ſort of land will, in general, be the moſt advantageous in the ſtate of graſs *.

The moſt beneficial ſorts of crops for theſe ſoils will, in general, be turnips, rape, or potatoes: where they have been pared and burned, the former may be ſown broadcaſt, and be eaten off by ſheep, when the land will be ready for ſome kind of grain crop with ſeeds. When the ground is very ſoft, the turnip or other ſeeds may be ſown immediately among the aſhes without ploughing, and be harrowed in with a ſmall harrow drawn by men, and afterwards rolled well down. In this way it ſoon becomes ſo ſolid as to admit the plough. Rape is more ſuitable for the firmer and more ſolid deſcriptions of land of this ſort, on account of its ſtrong roots, which have the tendency of opening and looſening the ſoil very conſiderably, as well as of rendering it highly mellow on the ſurface, by the thick ſhade of the leaves. The light and drier parts will be the moſt adapted to potatoes, as their bulbous roots will be there the moſt able to ſpread and extend themſelves, and conſequently produce large crops. Theſe crops will, in the ſtiffer ſorts of theſe ſoils, leave the land in a ſuitable condition for wheat or oats, and in the lighter for barley or rye. In ſuitable ſituations in reſpect to markets. theſe ſoils are well adapted for the growth of many ſorts of garden vegetables.

In moſſy ſoils of the more extenſive and deep kinds, which form a variety of this deſcription of land, different methods have been attempted in bringing them into the ſtate of tillage †. By ſome the whole of the moſſy material has been removed by the aid of water and ſuitable machinery, ſo contrived as to raiſe it above the level of the moſs. It has been ſtated by a late writer that the expence of a machine for this purpoſe, and the embankment neceſſary for it, in the caſe of an improvement of this ſort made by the ſon of Lord Kames, was £.1000 ‡, and it has been ſuppoſed to be even £.1500. It is obſerved, that when the water arrives at the higheſt part of the moſs, it is conveyed in a rut perpetually deſcending along the whole line of the uncleared moſs; at every part of this line the people are employed in throwing the moſs into the ſtream with ſpades. Thoſe at the part where the water firſt enters the moſs, keep the ſtream upon the ſurface, and they lift and throw into it all the moſs within their

* See ſection on the Cultivation of Graſs Land.

† The nature, formation, and analyſis of theſe ſoils have been ſo fully treated of by Dr. Anderſon, in his Eſſay on Peat Moſs; and Mr. Headrick, in his paper On the Modes of bringing Waſte Lands into a State fit for Cultivation; that we think it unneceſſary to deſcribe them.

‡ See Robertſon's Survey of Perthſhire.

reach, until they uncover the clay below; they then cut out a new water-courſe, and throw into it the embankment of moſs which ſuſtained the water before: thoſe lower down operate in the ſame way, only they preſerve the current of water on a lower level than thoſe above them; thoſe at the loweſt part keep the water running upon the clay, and ſhift its courſe occaſionally, ſo as to have it running along the bank or face of uncleared moſs: thus, at every point along this water-courſe, people may be employed in heaving in pieces of moſs by the ſpade, and they conſtantly ſhift the poſition of the ſtream, in proportion as the moſs is cleared away * †.

The ſoil that preſents itſelf after the moſſy matter is conveyed away in this manner, is a ſort of clayey marle, with a conſiderable mixture of marine ſhells in different places. Its natural fertility is conſiderable, but found to be much improved by being raiſed into pretty high ridges, and expoſed to the influence of the atmoſphere during the winter ſeaſon immediately after its being firſt broken up. Lime, peat, aſhes, and manures of the dung kind, are afterwards applied to it with beneficial effects in promoting its improvement. It has been ſuggeſted, that as lime, which is highly neceſſary to ſuch ſoils, cannot be eaſily procured in many places, while ſea ſhells are in abundance, they might be eaſily dug up and converted into lime by a moderate degree of heat. It is probable too, that by being broken or otherwiſe reduced into a fine powder without calcination, they might frequently be applied with conſiderable improvement; though in the ſtate of quick lime they would be more uſeful in ſome caſes, by their more ready combination with the acid matters of ſuch ſoils: this would ſeem to be moſtly the caſe where the moſſy matter had not been floated away, by which a heavy expence might be ſaved. Where muſcles or other ſorts of ſhell-fiſh are to be procured in ſufficient quantities in the neighbourhood of the moſſes, they might alſo be employed with benefit, when reduced by a mill, ſimilar to thoſe employed in grinding oak bark, and afterwards incorporated with a large proportion of good peat or other earth; as by this means calcareous matter, as well as a rich animal manure, would be at once applied. But, independent of the circumſtance juſt mentioned, the floating

* See Communication to the Board of Agriculture, p. 309.

† Mr. Headrick found on enquiry, that in this way it required the labour of a man nearly a whole year to clear one Scotch acre of moſs, and reduce it into a condition to receive a crop. This labour cannot be eſtimated, he ſays, at leſs than £.25; to this add the price of ſeed, compound intereſt upon the original erection of the machine and embankment, &c. and the expence of this mode of cultivation will not, he thinks, appear trifling.

of moſſes can only be practiſed in inſtances ſimilar to the above, where the ſub-ſoil is rich and good, as in moſt ſituations it has been found that the bottom ſoil is either compoſed of rocky materials, whitiſh granite, or pyritical gravel, and pyritical and aluminous clay *, which muſt conſtitute a ſoil much worſe than the peat-earth, and which could ſeldom be cultivated to advantage.

Another method of bringing this ſort of ſoil into cultivation, and which in many ſituations is much readier and leſs expenſive, as being accompliſhed without the floating of the moſs: this is by the application of lime in its cauſtic ſtate, in large quantities, after the land has been rendered as dry as poſſible by the cutting of large ditch drains. This is a method of practice that has been carried to a great extent, and conducted with much ſucceſs, in Ayrſhire, in Scotland †, and which has ſince extended itſelf over different diſtricts in the ſame neighbourhood. The benefits reſulting from the cultivation of this ſort of ſoil are ſuch as to render it an object of great attention. Such, indeed, are its advantages there, that "the culture of moſs has become, in many caſes, a diſtinct ſpecies of farming, to which individuals apply to the neglect of every other purſuit ‡."

* See Headrick, in Communications to the Board of Agriculture, vol. II. p. 311.

† It ſeems from Mr. Headrick's account, to have been accidentally introduced by John Smith, eſq. of Swinridge Muir, near Beith.

‡ It is obſerved by Mr. Headrick, that the following detail may aſſiſt the inexperienced to form ſome idea of the value put upon moſs by thoſe who are acquainted with it: A young man, ſon of a farmer on the eſtate of Swinridge Muir, has taken 20 acres of moſs from William Patrick, eſq. of Trehorn, writer to the ſignet in Edinburgh, for four crops, at 25s. per acre of yearly rent. All that was done by the proprietor was to dig the maſter drains, which alſo ſerve the purpoſe of fences; in other reſpects the moſs was delivered in its wild and unſubdued ſtate, the tenant being at all the expence of working and manures, and obliging himſelf to lime, at the rate of ten Ayrſhire chalders per acre. The moſs was in crop, 1797, for the firſt time. Mr. Headrick was ſeveral times upon it, and remarked, that where the lime had been early enough applied, which was the caſe with the greateſt part of it, the crop (oats) was uncommonly good; even the worſt was much better than ſome contiguous land which had been torn from Muir, and limed. On a ſmall corner, which had got no lime, nothing grew. The proprietor himſelf expected no ſuch rent, had it not been voluntarily offered by the tenant. The ſolid land there, which has been long in cultivation, does not average 20s. of rent, as the ſituation is not very acceſſible.

Two ſmall patches of cultivated moſs, contiguous to the town of Beith, were lately let at the rate, the one of £. 10 per acre per annum, for two crops of potatoes, the other for £. 7 per acre for two crops of oats, to be ſown down with graſs ſeeds. The firſt of theſe patches had been conſtantly in potatoes ever ſince it was reduced to cultivation, and the occupants were to furniſh what dung they choſe for their crops at their own expence. The ſecond patch, of more than three acres, had been conſtantly either in potatoes or oats from the time of its firſt ſubjugation, and would have given much more, had potatoes been permitted; but it was thought adviſable to bring it into graſs. It muſt be

The manner of proceeding in bringing this ſort of land into tillage is ſo well deſcribed by the author of the valuable paper we have juſt quoted, that we ſhall inſert it in his own words. "In entering upon the improvement of a moſs in its natural ſtate, the firſt thing to be done is to mark out and cut main or maſter drains, eight feet in width by four and a half in depth, and declining to two and a half at bottom; theſe coſt one ſhilling per fall of ſix Scotch ells. In ſome inſtances it will be found neceſſary to cut theſe drains much deeper, conſequently at a greater expence. Theſe drains almoſt in every inſtance can, and are ſo conducted as to divide the field into regular and proper incloſures. They always make it a rule to finiſh off as much of a drain as they have broken up before they leave it at night, becauſe if a part is left dug, ſuppoſe half way, the oozing of water from the ſides would render the bottom ſo ſoft that they could neither ſtand upon it nor lift it with the ſpade. When the moſs is ſo very ſoft that the preſſure of what is thrown out of the drain may cauſe its ſides to fall in again, they throw the clods from the drain a conſiderable way back, and ſometimes have a man to throw them ſtill further back, by a ſpade or the hand; for this reaſon too, they always throw the ſtuff taken from the drain as equally as poſſible on each ſide of it. In digging the drains, the workmen ſtand upon ſmall boards, to prevent them from ſinking, and move them forward as the work advances. When the moſs lies in a hollow with only one outlet, it is neceſſary to lead up a drain, ſo as to let the water paſs this outlet, and then conduct it along the loweſt or wetteſt part of the moſs; this middle drain is afterwards ſloped, and the ſtuff thrown back into the hollows that may occur; upon it, the ridges are made to terminate on each ſide, while a ring-drain, ſerv- in the purpoſe of a fence, is thrown round the moſs at the line where the riſing ground commences. This can generally be ſo managed as to divide the moſs into a ſquare field, leaving ſtraight lines for the ſides of the contiguous fields. The ring-drain intercepts the ſurface water from the higher grounds, and conducts it into the lower part of the outlet, while the ſloped drain in the centre receives and diſcharges all the water that falls upon the moſs. After the moſs collapſes, in conſequence of liming and culture, it is often neceſſary to clean out theſe drains a ſecond time, and to dig them to a greater depth: their ſides become at laſt like a wall of peat, which few animals will venture to paſs."

admitted, that land immediately contiguous to a town fetches a rent for conveniency, as well as for what it actually produces; at the ſame time it muſt be obſerved, that the beſt ſolid land to which theſe patches of moſs belonged, and ſome of which had been long in paſture, brought only a rent of from £. 3 to £. 6 for two years' crop, the whole being let in parcels by public auction.

In cutting theſe drains in the moſſes in Lancaſhire, one precaution has been found of the utmoſt importance; which is, that if the drain be cut to its intended depth at one operation, it will be impoſſible to prevent the ſides from falling in, and no labour can afterwards effectually repair the damage. It is highly neceſſary, therefore, to attend to the nature and conſiſtence of the moſs, and not to cut deeper at one time than will ſuffer the ſides to remain perfectly firm *.

When this buſineſs has been performed, the ridges, according to the firſt writer, are marked out, either by a line, or three poles ſet up in a line of the proper breadth, and formed in a way that will be mentioned when we come to ſpeak of ridges. Theſe are then to be top-dreſſed with lime. The ſooner, ſays he, this is done after the ridges are formed the better. When the moſs appears dry, experienced farmers throw on the lime, but do not clean out the diviſion furrows until the enſuing winter. When it is ſoaked in water, and the the lime is ready, they clean the diviſion furrows, and after the water has run off, apply the lime immediately. It is of great importance to have the lime applied while the moſs is ſtill moiſt, and the lime in as cauſtic a ſtate as poſſible. For this purpoſe they have the lime conveyed from the kiln in parcels, ſlaked, and laid on as faſt as the ridges are formed. Being dropped from carts, and ſlaked at the neareſt acceſſible ſtation, it is carried to the moſs by two men on light hand barrows, having a hopper and bottom of thin boards, and there ſpread by ſhovels as equally as poſſible. During the firſt and ſecond years, the crop is generally carried off in the ſame way. In ſome places, where a moſs is covered with coarſe herbage, and acceſſible by carts in dry weather, he ſaw them give a good doſe of lime to the moſs before it was turned up with the ſpade, and another after the ridges were formed. It is ſurpriſing, he ſays, how quickly they execute theſe operations with the hand-barrows. In other places where coarſe boards can be procured, they lay a line of them along the crown of a ridge, and convey the lime upon them in wheelbarrows.

"The proportion of lime allowed to the acre is various, being from three to eight chalders. Improvers are much leſs ſparing of this ingredient now than formerly, and much greater proportions have been applied with good effect. Suppoſe 120 bolls, or 480 Wincheſter buſhels, of ſlaked or powdered lime allowed to every Scotch acre; this would coſt at the ſale kilns forty ſhillings; and thus the reader may be enabled to calculate the expence of lime per acre in this diſtrict, at every given proportion: but moſt of the farmers here burn lime for themſelves in vaſt kilns of ſod, and think they have it much cheaper than it could be

* Agricultural Report of Lancaſhire, p. 95.

got from a ſale kiln. In many places lime-ſtone abounds ſo much, that houſes, fences, roads, &c. are conſtructed with it; and when a farmer burns the lime-ſtone within his premiſes, he at leaſt ſaves the expence of carriage. In ſome caſes, after the lime is laid on, they go over the ground with hoes or with ſpades, hacking and mangling the clods, and mixing the lime more completely with the ſuperficial ſoil; but where there is much to do, and hands are ſcarce, they ſeldom think of theſe operations.

After the land has undergone this preparation, it is in a ſuitable condition for the reception of the ſeed, which it is obſerved is ſown at the uſual ſeaſon, whether it be *wet* or *dry*, and, as has been already ſeen, harrowed in by a ſmall harrow, drawn by two men *. It is ſtated that four men will with eaſe harrow at leaſt five or ſix roods per day, two and two dragging the harrow by turns, and two breaking and dividing the mold with ſpades. Where the liming has been accompliſhed at an early period in the preceding ſummer, a good crop may moſtly be expected; but if it has been only recently performed, the firſt crop frequently fails, from the lime not having had time to combine ſufficiently with the moſs ſo as to form it into a ſoil †. It is probable that this does not, however, wholly depend on the lime not having reduced the peaty earth to the proper ſtate of ſoil, but partly on its not having neutraliſed and deſtroyed the acid properties of ſuch ſoils.

In reſpect to the crops moſt proper to be cultivated on ſoils of this kind, ſome variety may be admitted, according as they are more or leſs wet, and have greater or leſs depth. But, as a chief point to be aimed at in cropping them at firſt, ſhould always be that of preventing their ſurfaces from being too much acted upon by the ſun and wind, ſuch plants ſhould be provided as have a tendency, by the luxuriancy of their growth, and the cloſeneſs of their foilage, to afford as much ſhade and covering as poſſible, as by the moiſture being thus preſerved the operation of the lime is much promoted. In this view, potatoes, turnips, winter rye, and rape crops, may, in the ſlighter boggy ſoils, be had recourſe to with ſucceſs. The firſt is a ſort of plant that has been found to anſwer ſo well, and been ſo highly productive on all moſſy ſoils, that it is the general practice, where manure can be procured, to cultivate them for the firſt crop; the cuſtom, in moſt inſtances, being to ſet them on beds or ridges a little raiſed. Where potatoes are grown more than one year on the ſame land, the ſecond crop may frequently be put in without dung. Turnips and rape may, however, in many caſes, be grown with great advantage, as firſt crops, on ſoils of this deſcription, both

* See Communications to the Board of Agriculture, vol. II. p. 318. † Ibid.

on account of their great value, the ſhade they produce, and their being capable of being put into the ground without ſo much digging as is neceſſary for potatoes.

Moſs-lands *, from their being much diſpoſed to the throwing up of graſs, are not ſo proper for the growing of grain crops, but a crop or two may frequently be taken after potatoes or turnips, eſpecially where the liming has been performed ſome length of time. Oats and barley are moſtly good crops, but ſuch land is often too light for wheat. The early white Poliſh oat is generally recommended in ſuch caſes, as being the leaſt liable to lodge, or run too much to ſtraw. Where barley is employed, graſs ſeeds are frequently ſown with it, but it is probably a better practice to put them in ſeparately. On thoſe ſoils, rye-graſs, as well as white and yellow clover, have been found to thrive extremely well, eſpecially where they were in a proper ſtate of preparation for them, as by the growth of potatoe or turnip crops. And though red-clover has not always ſucceeded, it is probable, that in ſuch moſſes as are not of the deep kind, it will be found an uſeful plant. In ſome diſtricts it has been found, that clover may be ſown with great advantage immediately after the potatoe crop, when it has been taken off early †.

And as it is neceſſary that there ſhould be a tolerable proportion of moiſture conſtantly preſerved in theſe ſoils, in order to promote the full operation of lime upon them, it would ſeem to be the moſt advantageous method in bringing

* It is obſerved, by Mr. Headrick, in the ſecond volume of Communications to the Board of Agriculture, that in Scotland the expence of delving a moſs for the firſt time, where the ſurface is tolerably ſmooth, is $2\frac{1}{2}d.$ per fall, or £.1. 13*s.* 4*d.* per Scotch acre; but where inequalities occur, which muſt be thrown by the ſpade into hollows, it coſts about £.2. per acre. If there be eminences, which muſt be removed into hollows, by wheelbarrows, running upon boards, the firſt expence is greater, according to circumſtances. The ſecond delving, where potatoes have not intervened, coſts from £.1. to £.1. 6*s.* per Scotch acre, the diviſion furrows being at the ſame time cleaned out. The third delving, and cleaning of the diviſion furrows, coſt £. 1. per acre; but the moſs is then ſo friable, that it may be wrought with the greateſt eaſe and rapidity. At the above rates, an ordinary workman will earn 1*s.* 6*d.* per day; and an able and experienced one, from that to 2*s.* 6*d.* per day. They uſe a ſtrong ſpade edged with ſteel, and have alſo a gritſtone near them, for ſharpening the ſpade. In the evenings they repair its edge upon a grindſtone, and when the ſteel is worn away, they lay it again with new ſteel. Sometimes the moſs is ſo ſoft, that they walk upon boards while they are turning it over.

And that when moſs is wrought by the ſpade, it ſeems to be of no conſequence whether it be wrought wet or dry; but when it is wrought by the plough, opportunities muſt be watched, as horſes cannot walk upon it, for ſome years, during wet weather.

† See Agricultural Report of Lancaſhire, p. 99.

them into cultivation, not to allow them to be rendered too dry by the cutting of drains, but to proceed with the buſineſs in ſo gradual a manner, as that they may conſtantly retain that degree of moiſture which is moſt ſuitable for the complete action of the lime, without being too wet for the crops that are to be put upon them.

It is evident, from what has been advanced, that there is much variety in ſoils of this kind, and that they will of courſe require different modes of tillage. Where they are very thin, and depoſited upon a loamy or clayey ſubſtratum, it may be a good practice, after paring and burning the coarſe top ſward, to plough ſo as to bring up a portion of them, by which, and the uſe of lime, the land may be rendered highly productive. And indeed, where they are of much greater thickneſs, this method has been adviſed after their being ſufficiently reduced by frequent turning up, drying, and burning; but it is probably a better method to depend upon the application of lime, where it can be procured in quantity ſufficient for the purpoſe. After paring and burning, on lands of this ſort, the crops, eſpecially thoſe of the turnip, rape, or graſs kinds, may frequently be put in by means of a light harrow, without ploughing or digging them over.

Ridges.—In the conſtructing of ridges on ſuch lands as are to be brought into cultivation, great attention is not only neceſſary to the nature and quality of the ſoil, but alſo to its ſituation, as by theſe, their ſize, height, and direction, muſt in a great meaſure be regulated. Where the land is of ſuch a nature as to be highly retentive of moiſture, or, from the peculiarity of its poſition, liable to become too wet for the growth of uſeful crops, the ridges ſhould in general be made narrower, and have a more rounded or convex form, than in the contrary caſe, or where it is expoſed to injury from becoming too dry. But in the firſt caſe they ought not, however, to be raiſed ſo very high as is ſometimes the practice, as by ſuch means much inconvenience is often ſuſtained from the crowns becoming too dry, and the grain ripening in a ſlow and partial manner. Beſides, narrow ridges, with but a little elevation, are, in general, much more effectual, in taking away the water that may be injurious.

Where neither the circumſtances of the ſoil, nor the nature of its ſituation, require that the ridges ſhould be formed in a particular manner, or of any certain breadth, that of making them about eighteen feet may be the moſt ſuitable, as they are found to anſwer well in the way of keeping the ground properly dry, and of the moſt convenient dimenſions for turning the teams in

ploughing. Beſides, the ſeed, where this method is purſued, can be eaſily ſown by one caſt up and another down; an operation which, in other circumſtances, would be attended with conſiderably more labour. The covering of the ſeed by means of harrowing is alſo accompliſhed with more facility and diſpatch, as by employing double implements of this kind, one turn may wholly finiſh the buſineſs. In the reaping, too, they have advantages, in allowing the number of reapers that are neceſſary to work with convenience, and without being in the way of each other.

In wet, clayey, or any ſtiff and tenacious loamy ſoils, where the under ſtratum is clay, they ſhould, however, be ploughed as much as poſſible into ridges of much leſs ſize, in order that they may be kept in a ſtate of dryneſs, ſuitable to the growth of the crops that are to be put upon them. Three or four feet, according to the degree of tenacity and wetneſs, may, in ſuch ſorts of land, be fully ſufficient. In the counties of Eſſex and Hertford, on this ſort of wet ſoils, three feet are found to anſwer the purpoſe in a very effectual manner; and it has been obſerved, on the authority of much experience, that their ſuperiority over ridges of greater breadths, for taking the water off without waſhing the land, is incontrovertible*. In ſhort, as there is much variation in lands of theſe kinds, it may be obſerved, that the width and flatneſs of the ridges ſhould be increaſed as they recede from the nature of clay or clayey loam, and approach that of ſand, in order that a larger proportion of moiſture may be preſerved; while, on the contrary, as they are becoming more of a clayey quality, they ought to be narrower, and to have a more high and rounded form, that the diſcharge of injurious moiſture may be more expeditious. In loamy ſoils they ſhould be either broad and flat, or narrow and round, in ſome meaſure, according to the degree in which they approach the ſandy or clayey ſoils. In very wet, clayey ſoils, where they reſt upon a ſubſoil of ſome porous kind, great advantage in the way of drainage may often be obtained by ſinking the furrows ſo deep as to reach it.

In lands of the marſhy or fenny kinds, as moſtly approaching in ſome degree to the nature of theſe, the ridges ſhould alſo be made narrow and rather round.

As the principal defect of land of the ſandy kinds is that of parting with its moiſture too readily, and of courſe becoming quickly in a ſtate of too much dryneſs for the purpoſe of healthy vegetation, it is the moſt adviſable to plough them into very broad ridges, or even in ſome caſes quite flat, with-

† See Agricultural Survey of Middleſex, p. 144.

out the leaſt degree of furrow being made, as in this way the moiſture may be more effectually retained in ſuch ſoils.

In forming ridges on ſuch ſoils as are of the boggy or moſſy kinds, ſome attention is neceſſary in reſpect to their depth, and the proportion of wetneſs that may be preſent; as where they are thin, and have but little injurious moiſture, they may be more broad and flat, than where they are deep of moſs, and more retentive of moiſture: ſix or ſeven yards may, in general, be the beſt. But, even in the deeper ſorts, long experience has ſhewn, that in the firſt inſtance it is improper to make them too high or too narrow; where they are made too high, they throw the water off from their ſides, without admitting it to penetrate their ſubſtance, the top of courſe gets too dry; when too narrow, there is a loſs of ſurface from too many diviſion furrows: the breadths already mentioned are found to be the beſt: and when the improvement is completed, the ridges appear like ſegments of wide circles, with a clean well-defined diviſion furrow between each of them. The moiſture is thus cauſed ſlowly to filtrate through the moſs, rendered friable by lime, until it reaches the diviſion furrows, and is diſcharged. As the moſs ſubſides for ſome time, and cloſes in towards the furrows, it is generally neceſſary to clean theſe out before winter, and at the time the crop is ſown, until the moſs acquires ſolidity *.

The ridges in theſe ſoils are moſtly formed by the ſpade, the workman beginning nearly in the middle of the part which is to form the ridge, only leaving the ſpace of about eighteen or twenty inches, upon which the materials raiſed from the trenches on each ſide are depoſited, ſo as to conſtitute the crown; and in this way of digging up and turning over narrow ſpits on each ſide he proceeds till he comes to the diviſion furrows, which are cut out and laid on the ſides. The ridge being thus completed, and appearing as if done by the plough.

In deep moſſy ſoils, eſpecially thoſe of the more ſpongy kind, it is probable the breadth of the ridges may be increaſed with advantage after they have collapſed and become ſufficiently firm, as by ſuch means they will be more ſuitable for being laid down to graſs.

In regard to the direction of the ridges in lands of all deſcriptions, where there is not a neceſſity of giving them a particular poſition, either with a view to drainage, or ſome other circumſtance of importance, it ſhould conſtantly be, as much as the ſituation of the grounds will admit, in the line of north and ſouth; as in this direction much advantage may be obtained in the ripening and dry-

* Communications to the Board of Agriculture, vol. II.

ing of the crops, from their being more fully expoſed to the influence of the ſun and wind. It has, indeed, been remarked, that the ſhocks, after grain has been reaped, ſhould be ſet in the ſame direction, and not have an eaſt and weſt poſition, as in this caſe the ſheaves on the north ſide are many days later in being in a proper condition for being conveyed to the ſtack, than thoſe of the ſouth. Further experience has alſo afforded the means of ſhewing the bad effects of ridges having an eaſt and weſt direction; it being found that corn on the ſouth ſides, of ſuch as were not by any means high, ſhot into ear, and changed and ripened a week at leaſt earlier than that on the north; and that at the time of reaping, the wheat on the ſouth ſides was, in ſome patches, too ripe; while that on the north ſides was in many parts abſolutely green*.

In forming ridges in ſuch lands as are hilly, or have much declivity, it is neceſſary that they be neither made too ſteep, nor have too much of a horizontal direction, being drawn ſo as that they may have that ſort of eaſy ſloping direction, by which the water can be taken off in a gradual manner. In this way there will not only be great advantage in the economy of labour in ploughing, nearly one third leſs power in the team being ſufficient; but the injury and inconvenience of heavy rains waſhing down the ſoil and manure, are in a great meaſure prevented. The author of "The Gentleman Farmer" mentions the inſtance of a hanging field that had been carefully dreſſed with lime and dung for turnips, and in which the turnips were fairly above the ground, when a heavy fatal ſummer ſhower ſwept down the crop, together with the lime, dung, and a portion of the looſe ſoil, leaving the land bare and expoſed.

On the method of forming ridges in lands that have ſuch ſituations, it has been lately well obſerved, that when the fields hang ſo much as to be accounted ſteep, the ridges ought neither to be drawn parallel to the bottom of them, nor at right angles, ſtraight up and down; either of which would be inconvenient in the ploughing, and injurious to the ſoil. They ought to be drawn diagonally. The great point is to underſtand in what direction this diagonal ſlope of the ridges ought to run. In this reſpect the cultivators in his diſtrict are perfectly correct; and it is his wiſh that their example were followed by all farmers whoſe land has a great declivity, of which there is a conſiderable proportion, not only in that, but in all hilly countries whatever. The form and direction of the ridges are, he obſerves, contrived with ſuch judgment, that the furrow (or, as Lord Kames with more accuracy calls it, the furrow

* See Marſhall's Rural Economy of the Midland Counties, vol. II. p. 18.

ſlice) falls eaſily away from the mold-board, as well in aſcending as in deſcending the field, which is the principal ſecret. There can, ſays he, be no more than two diagonal lines in any four-ſided figure, which is generally the form of incloſures; and if you bring a ſenſible ploughman to each of the angles below, deſiring him to look towards each of the oppoſite angles above, he will at once tell you, which of theſe diagonal directions is eaſieſt for himſelf and his horſes, and will accordingly fix on that line by which the furrow *in aſcending* will fall moſt readily into its place, having his right hand and the mold-board of his plough with a ſide-aſpect to the bottom of the field. But, in order to render this more plain, ſuppoſe, ſays he, the field to have a ſteep deſcent and a ſouthern aſpect, the ridges are drawn from ſouth-weſt to north-eaſt; which is the caſe in the inſtance alluded to. Suppoſe again, ſays he, the field to have a northern aſpect, the ridges are drawn in the ſame direction, but with this difference in ploughing, that you *aſcend* ſouth-weſt in the laſt caſe, whereas you *deſcend* ſouth-weſt in the firſt. If the field fronts the eaſt, you aſcend north-weſt; if the field fronts the weſt, you deſcend north-weſt; or invariably four points forward from the ſlope of the field, in going up the hill.*

It is further remarked by the ſame able writer, that if, on the contrary, the ridges be made parallel to the bottom of the field, all the dexterity of man and the force of cattle that could be applied, would be inſufficient to turn every ſecond furrow up againſt the hill. The expedient univerſally employed, according to the old ſyſtem, in ploughing fields of this kind, was, ſays he, either to plough with a double mold-board, or, if the mold-board were ſingle, to plough only one furrow, in going twice the length of the ridge; but moſt frequently the laſt. Both are bad huſbandry. In the former method you loſe none of your time indeed, but one half of your labour is loſt by the latter. His principal objection, he thinks, holds equally againſt both. All the ſoil is year after year rolling downward, and in proceſs of time the upper part of the field will be peeled to the bone, and quite bare of ſoil, while a great bank is accumulating along the bottom, like a dunghill, compoſed of the richeſt land in the field: and withal the furrows are laid ſo completely on their back, that little benefit is derived from the manure, excepting it be laid on the ſurface the firſt year.

He alſo adds, that where a hill is to be dreſſed, in order to be laid down into graſs, it ought to receive the laſt furrow by going round in a ſpiral line, without ever turning the plough, beginning at the baſe, and ending at the top;

* See Dr. Robertſon's Survey of the County of Perth, p. 124.

as by this method leſs labour is required, and the appearance of the land is more beautiful. But in the preparation of the ground for this laſt furrow, it may be ploughed diagonally, with the view of keeping the ſoil from falling to the bottom, as has been noticed above; and in this intention the ſurface of the hill may be conveniently divided into three or more ſections. Beſides, in this way, no more ſtrength of team is required in ploughing ſuch elevations, than in that of ploughing on a level, while where the ſoil is of the gravelly or ſandy kind, the great inconvenience of the moiſture going off too quickly, is guarded againſt by its being detained in the furrows*. This ſpiral method of laying the furrow ſlices, is likewiſe recommended by the firſt writer, as the neateſt for finiſhing off a lawn or pleaſure-ground, near a reſidence, even where the land is flat, as it brings the whole ſurface to a regular uniform appearance, and prevents the unpleaſant effect of furrows on the eye.

On ſuch lands as are level, or have but little inequality of ſurface, the beſt general practice is, to form the ridges as ſtraight and as regular in reſpect to breadth as poſſible, as by having them crooked, and of irregular breadths, the water is not only liable to ſtagnate and injure the ſoil, but the friction in ploughing is greatly increaſed, and the furrow ſlice is not ſo well laid over, being more diſpoſed to fall back. And beſides, many unneceſſary turnings are requiſite, on account of the inequalities of breadth, by which much time is loſt, as well as much trouble given to the ploughman.

In old cultivated lands, where high, crooked, and irregular ridges are frequently met with, it often becomes neceſſary to have them altered, ſo as to render them more ſtraight and level †. This is, however, a matter of more diffi-

* See Gentleman Farmer, p. 75.

† Mr. Donaldſon obſerves, that in various parts of Great Britain, and eſpecially in the more fertile and populous diſtricts, the ridges are remarkably crooked, unequal in breadth, and made to riſe towards the middle, or crown, to the height of ſeveral feet above the furrows on either ſide. And that it is obvious that theſe are formed in the worſt manner, to anſwer the purpoſes which are now intended by dividing a field into ridges. It is not, however, he conceives, to be ſuppoſed, that this could have eſcaped the obſervation of all the farmers of former times. On the contrary, from the practice having been ſo general, it is more than probable that this form of ridges, which is now conſidered as abſurd, was once deemed, like many other ancient practices, an improvement; for on many of the hills in Scotland, where the lands are dry and tolerably level, and where cultivation had, no doubt, taken place at the earlieſt period, although now abandoned to the growth of heath (ling), the ridges are as ſtraight as any in the beſt cultivated parts of the iſland. The reaſons which induced the farmers of former times to form the ridges in the manner which now appears ſo objectionable, may, he ſuppoſes, be explained in

culty, and which demands more knowledge and care in its execution, than is commonly ſuppoſed. The moſt ſuitable period for accompliſhing the work where the plough is employed, is when the land is undergoing a courſe of repeated ploughings, as in the caſe of a fallow; as under ſuch circumſtances the more elevated parts of the field may be ploughed over as often, and in ſuch directions, as is moſt ſuitable for bringing them into a level ſtate. Where the ridges are not raiſed to any very conſiderable height in their middles, but badly formed in other reſpects, they may ſometimes be readily brought into proper order by being ſplit, or cloven down occaſionally; a mode which is performed by beginning at the furrows, and terminating at the crown, or middle of the ridge, ſo that the former furrows become the crowns, and the new furrows are made in the middle of the old ridges, which being filled by a furrow from each ſide, has the tendency of ſoon bringing them into a more equal and level form.

Where the ſoil is of the light, gravelly, or open and mellow kind, the plough may be conveniently employed in levelling the ridges, without producing any injury of conſequence to the crops that may afterwards be put upon the land. It is proper, however, even in lands of theſe kinds, to uſe much caution in performing the operation, in order to avoid the injury that might be cauſed by too large a proportion of the under-ſoil being brought to the ſurface in different parts of the ground.

It is aſſerted, by Dr. Anderſon, that where this is done by ſuch implements as are contrived for expeditiouſly bringing them to this ſituation, as ploughs, harrows, drags, &c. the farmer of neceſſity buries all the good mold that was on the top of the ridges in the old furrows; by which he greatly impo-

the following manner: When the lands were generally cultivated in the open field, or run-ridge ſtate, the furrows of the ridge were commonly the march between one farmer and another. The portion of land belonging to each tenant in any one place was thus ſo ſmall, as to prevent him from uſing any other method of draining, than that of raiſing the ridge ſo high as to allow the water to run off in the furrows, without doing damage to the crop. All the ridges which are broader at one end than the other, will, he thinks, generally be found narroweſt at that end of the ridge which is ſtill moſt wet and ſpouty. It is, therefore, more than probable, that the ridges were purpoſely made narrow at that end, as the only means by which lands ſo poſſeſſed could be drained. As the moſt crooked ridges are on ſteep and ſloping grounds, it may be preſumed, that prudence directed the firſt cultivators to adopt that poſition of ridges, in order to prevent the ſoil from being waſhed away by ſudden falls of rain; which would no doubt have been the caſe to a greater degree, had the ridges been all ſtraight. Each furrow becoming a ſmall rivulet, and having nothing to impede its courſe, muſt have done more injury to the ſoil than if it had run off in the circuitous courſe formed by the crooked ridges.

veriſhes one part of his field, while he too much enriches another; inſomuch, that it is a matter of great difficulty, for many years thereafter, to get the field brought to an equal degree of fertility in different places: which makes it impoſſible for him to get an equal crop over the whole of his field, by any management whatever: and he has the mortification frequently, by this means, to ſee the one-half of his crop rotted by an over-luxuriance, while other parts of it are weak and ſickly, or one part ripe and ready for reaping, while the other is not properly filled; ſo that it were, on many occaſions, better for him to have his whole field reduced at once to the ſame degree of poorneſs as the pooreſt of it, than have it in this ſtate. An almoſt impracticable degree of attention in ſpreading the manures, may indeed in ſome meaſure, he thinks, get the better of this diſeaſe; but it is ſo difficult to perform this properly, that he has frequently ſeen fields that had been thus levelled, in which, after thirty years of continued culture and repeated dreſſings, the marks of the old ridges could be diſtinctly traced when the corn was growing, although the ſurface was ſo level that no traces of them could be perceived when the corn was off the ground. But this, he obſerves, is a degree of perfection in levelling that cannot be uſually attained by following this mode of practice, and therefore it is but ſeldom ſeen; for all that can be expected to be done by any levelling machine, is to render the *ſurface* perfectly ſmooth and *even* in every part at the time that the operation is performed: but as in this caſe the old hollows are ſuddenly filled up with looſe mold to a great depth, while the earth below the ſurface, upon the heights of the old ridges, remains firm and compact, the new-raiſed earth, after a ſhort time, ſubſides very much, while the other parts of the field do not ſink at all; ſo that in a ſhort time the old furrows come to be again below the level of the other parts of the field, and the water, of courſe, is ſuffered in ſome degree to ſtagnate upon them, inſomuch that in a few years it becomes neceſſary once more to repeat the ſame levelling proceſs, and thus renew the damage that the farmer ſuſtains by this pernicious operation.

On theſe accounts, if the farmer has not a long leaſe, it will be found in general, he thinks, to be more for his intereſt to leave the ridges as he found them, than to attempt to alter their direction: and if he attends with due caution to moderate the height of theſe old ridges, he may reap very good crops, although, perhaps, at a ſomewhat greater expence of labour than he would have been put to upon the ſame field, if it had been reduced to a proper level ſurface, and divided into ſtraight and parallel ridges.

But where the land is of a clayey, loamy, or more tenacious and wet quality,

there will be more difficulty, as well as more attention required, in levelling and changing the ſhape of the ridges; as it frequently happens that in ſuch ſorts of ſoil, after the earth from the crowns has been removed in order to render the ridges level, eſpecially where done by mechanical means, a coarſe, unfriendly, ſtiff ſoil, is brought up, that requires ſo great a length of time, and ſo much amelioration to bring it into a ſtate capable of ſupporting good crops, as can not be compenſated by the advantages that may be obtained by the improvement in the form of the ridges; beſides, it is ſeldom poſſible to accompliſh this on ſuch ſoils without the danger of doing great injury by poaching. Hence it has been recommended not to be attempted, except in caſes of conſiderable length of leaſe*.

It may, however, in particular inſtances, be neceſſary, and highly beneficial, to have the buſineſs performed, though it ſhould be attended with much trouble and expence, which in diſtricts where labour is cheap may probably be beſt executed by means of the ſpade, as in this method the vegetable ſurface mold may ſtill be preſerved on the top for the reception of the crop, and no injury be ſuſtained by the bringing up of the ſub-ſoil. From the loſs and inconvenience that attend this proceſs, where machines are employed, Dr. Anderſon adviſes that they be wholly laid aſide, and that the following practice, which he has found ſucceſsful, be had recourſe to.

When the buſineſs is to be done, let a number of men be collected with ſpades, and then ſet a plough to draw a furrow directly acroſs the ridges of the whole field, intended to be levelled. Divide this furrow into as many parts as you have labourers, allotting to each a ridge or two, more or leſs, according to their number and the height of the ridges. Let each of the labourers have orders, as ſoon as the plough has paſt the part aſſigned him, to begin to dig in the bottom of the furrow that the plough has *then* made, about the middle of the ſide of the old ridge, keeping his face to the old furrow, working backwards till he comes to the middle of the old ridge, going deeper as he proceeds, according to the height he has to bring down; then let him turn towards the other furrow, and repeat the ſame on the other ſide of the ridge, ſo as to leave the bottom of the trench he has thus made acroſs the ridge entirely level, or as nearly ſo as poſſible. When he has finiſhed the part of the furrow allotted to him, which the plough has made in going, let him then go and finiſh in the ſame manner his own portion of the furrow, which the plough makes in return-

* See Gentleman Farmer, p. 76; and Anderſon's Eſſays, vol. I.

ing. It is obſerved, that the old furrows ought to be raiſed to a greater height than the middle of the old ridges, ſo as to make allowance for the ſubſiding of the looſe earth with which they are filled.

It is alſo recommended, that theſe temporary or croſs ridges be made 40 or 50 yards broad at leaſt: for, although ſome time will be loſt in turning at the ends of the broad ridges, the advantage that is reaped by having few open furrows is more than ſufficient to counterbalance this loſs: and, in order to moderate the height that would be formed in the middle of each of theſe great ridges, it will always be proper to mark out the ridges, and draw the *furrow* that is to be the middle of each ſome days before the labourers are collected to level the field, to prevent any hurry or loſs of labour in the future operation of levelling. This breadth may be proper, where the land is ſufficiently dry, but in wet, ſtiff ſoils, it ſhould be much leſs *.

* The following eſtimates, though greatly below the preſent price of labour, may ſhew the advantages of the different modes in reſpect to expence:

Suppoſing the price of labour in Scotland to vary in different places from ſix pence to one ſhilling, and that the medium price be fixed at nine pence per day; and that the hire of a plough, with four horſes and two ſervants (for ſo many, in general, will be requiſite to labour properly ground in the condition that this is ſuppoſed to be in), varies in like manner from three to five ſhillings per yoking, and that the medium price of this be called four ſhillings; in this caſe, the comparative expence of levelling, by theſe two different modes, would, the doctor ſays, be as follows:

Eſtimate of Expence of levelling by the Spade.

	s.	d.
For wages to eleven labourers one day, at nine pence each, - -	0	8 3
For the hire of a plough 2½ yokings, at four ſhillings each, -	0	10 0
Total expence of one day's work,	0	18 3

Eſtimate of Expence of levelling the ſame by the Plough and Harrows.

	s.	d.
For 2 yokings and a half of a plough, as before - - -	0	10 0
For harrowing ditto, ſuppoſed at 1-4th of the ploughing, -	0	2 6
Total for once ploughing, &c. -	0	12 6
The ſame five times more repeated,	3	2 6
Total expence of levelling by plough and harrows, - -	3	15 0
Total expence of levelling by the ſpade, - - -	0	18 3
Difference, —	2	16 9

But though the levelling in this way may have been performed in the moſt perfect manner, ſomething further is, it is obſerved, required to bring the land into the moſt proper condition; as the earth below the plough furrow, at the crown of the former ridges, is ſolid, while that by which the former ſide furrows has been levelled is looſe, there muſt be a prejudicial inequality that is neceſſary to be obviated. This is recommended to be removed by employing a foot-crow, to dig and looſen the earth below the ſurface plough furrow in the middle of the former ridges, as much as poſſible, without turning it up. By this means, and leaving the former furrows a little more elevated than the old crowns of the ridges, the operation will be very complete *.

There are other methods in which this operation may be well and conveniently performed. It has been propoſed, by Dr. Robertſon, in his valuable Report of the State of Agriculture in the County of Perth, to begin the proceſs by removing the *made* or meliorated ſoil, on the crown of the ridge, to one ſide; which may be done by two or three ploughings in one direction, turning the furrow always one way. This is eaſier, he thinks, than doing it with the ſpade. Then ſuch a quantity of the buried ſoil may be caſt with the ſpade from the crown of the ridge, as will fill up the furrows at pleaſure: and laſtly, the meliorated ſoil may be ſpread over the ſurface of the whole. If it is not thought enough to ſave the meliorated ſoil on the crown of the ridge alone, firſt one ſide of the ridge may be taken, and then the ſame proceſs repeated on the other; by which means almoſt all the wrought ſoil may be kept on the ſurface. A good ſummer fallow, a hearty doſe of lime, and the mixture of wrought mold, will, he ſays, re-animate the new ſoil, and reſtore its vegetative power to its primitive ſtate; and a very few ſeaſons will naturalize the whole ſoil, while the farmer has the advantage of ſtraight ridges, moderately raiſed.

When the ſituation of a field is ſuch as to render it incapable, or very inconvenient, to be ploughed acroſs, a method, but which is leſs perfect, may be employed; which is, firſt to *cleave* out each ridge in ſuch a way, as to leave an open furrow in the middle of it; in doing which, about a yard on each ſide of the old furrow ſhould be left untouched, which, when the whole field is ploughed over, will conſtitute ditches of ſome depth between the ridges. The labourers are then to be ſent into the field with ſpades, in order to dig out trenches in the openings in the middle of the ridges, of depths proportioned to their heights, the earth thus removed being thrown into the furrows on the ſides.

* See Anderſon's Eſſays, vol. I.

After the whole has been dug out in this manner from one to the other, the plough is to be again made uſe of to turn back a furrow of the ſurface mold from each ſide into the new-formed trenches; the diggers then beginning again to work in the bottom of this new-formed furrow, throwing the earth conſtantly into the hollows between the old ridges. If by theſe means they be not ſufficiently raiſed, another furrow muſt be turned back into the trenches, and another new one dug out after it, repeating ſuch ploughings and diggings alternately, as often as may be found neceſſary for the purpoſe. The whole being in this way brought to a proper level, it ſhould be harrowed acroſs, if the plough cannot be uſed, in order to blend all the materials of the ſoil as well together as poſſible.

The expence of performing the buſineſs in this manner, is rather more than in the former method, as well as the levelling leſs completely effected; ſo that, unleſs where a ſuitable number of labourers for managing cannot be obtained, or ſome other matter intervenes, the other method will always be adviſable in preference to it. Yet this is much better than any of thoſe methods uſually made uſe of with machinery*. It is obſerved, that by either of theſe two methods the farmer has the ſatisfaction of getting his ground reduced to a proper evenneſs at once, ſo as to reap the full benefit of a ſummer-fallow, or any other operation that he may think proper. But as the earth below the ſurface muſt for ſome time be unequally firm, as has been already ſhewn, it will be neceſſary to lay it into narrow ridges for ſome years at firſt, and keep the furrows perfectly open and clean, to prevent, as much as may be, the water from ſtagnating too much among the looſe porous earth that fills up the old furrows. In this view, the *two-bout* ridges, as they are called, may be the moſt advantageous when they can be eaſily and perfectly formed.

But as the plough, when judiciouſly employed, is by much the moſt eaſy and expeditious method, and alſo that which can be the moſt generally made uſe of, on account of the ſcarcity of labourers, in many ſituations, it will be proper to attempt the buſineſs by that implement, before the more expenſive one of the ſpade be had recourſe to. And by directing the plough in different lines of direction, according to the particular circumſtances of the caſes, it will be found to anſwer the intention in many inſtances where the uſe of the ſpade might at firſt ſeem to be neceſſary.

Ploughing.—This, or ſome other method of looſening and turning up the ſupe-

* Anderſon's Eſſays, vol. I.

rior parts of ſoils, is conſtantly requiſite in order to render them ſuitable for the reception of the ſeed or crop that is to be cultivated. It is by means of this kind that a convenient bed for the roots of the young plants, and a proper condition of the land for ſupplying them with due nouriſhment, is in a great meaſure provided, as well as a proper ſtate of dryneſs in many caſes afforded. Hence, in performing the operation, it becomes a matter of conſiderable utility and importance to the agriculturiſt, to pay particular attention, not only to the ſtate and nature of the ground, but alſo the ſeaſon of the year, and kind of crop that is to be grown, as in this way he may frequently render the preparation of his lands more perfect and ſuitable, and at the ſame time obviate ſome of the natural defects under which they may labour. Thus, in almoſt every deſcription of ſoils, ploughing them up before the latter part of the autumnal, or beginning of the winter ſeaſon commences, renders them capable of imbibing and retaining a large proportion of moiſture for the ſucceeding ſummer; while the turning them up during the ſpring and ſummer, cauſes much waſte and diſcharge of moiſture, by evaporation and other means. Therefore, where the ſoil in its natural ſtate is too dry, and poſſeſſes too little tenacity for the growth and ſupport of ſuch crops as are neceſſary to be put into the earth in the ſpring months, the land, by being fully brought into a ſtate of preparation for the crop in the autumn, and the ſeed introduced without any additional ploughing in the ſpring ſeaſon, may be preſerved in a more moiſt and adheſive condition, conſequently in a more proper ſtate for the growth of ſuch crops; but where the ſoil is naturally moiſt, and the crops that are to be cultivated require that it ſhould be dry and mellow, when they are put into the ground, the ploughing, by being deferred for the winter, and performed as late as poſſible in the ſpring months, when it is become a good deal dried, will be the more advantageous for the crops that are to be grown upon it.

But, beſides theſe, there are other circumſtances that conſtantly demand notice in the practice of ploughing land. In all the ſtiff, heavy, and more adheſive kinds of ſoils, that are much diſpoſed to the retention of moiſture, whether they be perfectly clayey, or have more of a loamy quality, it ſhould be a common rule never to plough or turn them up when wet in any great degree, except where the nature of the crop requires it; as when ſuch ſorts of land are ploughed under ſuch a condition, the parts of which they are compoſed are very apt to cake and run together into hard lumps, that require much trouble and difficulty to be afterwards reduced into a fine ſtate. And further, great injury is produced by the treading of the team, as well as a much greater

power neceſſary in performing the operation. But, at the ſame time, they ſhould not be permitted to become ſo dry and hard as to afford too great reſiſtance in that way, before the operation is proceeded upon. Some, however, ſuppoſe, that all thoſe ſoils in which clay prevails over the other ingredients may be ploughed even when wet, without any injury being done, if the buſineſs be accompliſhed before the ſetting in of the winter froſts; but that the teams had much better remain totally idle than draw a furrow in the ſpring, until the ground be in a ſufficiently dry ſtate *.

The marſhy, moory, and peaty or moſſy deſcriptions of ſoils are in general, when in a ſtate of tillage, to be ploughed when the ſeaſon is dry, as they can ſeldom be wrought to advantage, and frequently not at all, when they are wet to any conſiderable degree.

But in the dry, ſandy, and probably in ſome of the more mellow and friable kinds of loamy ſoils, the buſineſs of ploughing, eſpecially for the putting in of the ſeed, may be performed when they are in a ſtate of conſiderable moiſture, not only without their ſuffering any inconvenience, or the ſeed being injured, but often with advantage, as they are liable to part with the watery particles that they contain too readily. On this laſt account the very dry ſorts of ſandy land ſhould, whenever the weather is hot and dry, merely be ſtirred in ſuch way as may be neceſſary to prevent the growth of weeds, otherwiſe the great exhalation of moiſture in ſuch ſeaſons may render them too dry for the healthy vegetation of the ſeeds or plants that may be ſown or ſet upon them. The cultivators of ſoils of this nature have, therefore, many advantages over thoſe who are engaged on the more ſtiff and heavy ſorts of land, in being able to perform the various operations of arable huſbandry with much leſs ſtrength and expence of team, and by being much leſs interrupted by the wetneſs of ſeaſons.

In regard to the depth and frequency of ploughing lands, they moſt conſtantly depend, in a great meaſure, upon the qualities and the ſort of crops that are to be grown. But in general the different preparatory ploughings ſhould be deeper than thoſe of the ſeed furrow, which ought moſtly to be light, and the ſlice not too much laid over, that the ſeed, eſpecially where the broad-caſt method of ſowing is adopted, may be the more perfectly covered.

It is well obſerved on this ſubject, by an able practical writer, that though deep ploughing has been greatly recommended by ſome modern writers, upon particular kinds of land, where the bottom and top are of two oppoſite qualities, and

* Communications to the Board of Agriculture, vol. III. part i. p. 45.

neither of them perfectly good, that a mixture may ſometimes be very beneficial, and the experiment of going below the common depth ſometimes anſwer. But that where the top and bottom, for eighteen or twenty inches depth, conſiſts of the ſame ſoil, he does not believe it is ever worth while to exchange the upper part, which has been enriched for centuries back, for a part leſs rich, merely becauſe it is more freſh. He has, indeed, he ſays, obſerved, that deep ploughing (except for ſome particular grain and plants) is by no means neceſſary. The vegetation of ordinary corn and graſs does not require any great depth. In many parts of *Cornwall* the land is, he aſſures us, exceedingly fruitful, though the ſoil is extremely ſhallow; and in many other counties they find, by experience, that they ruin their land by ploughing below the uſual depth. Beſides, when land is ploughed very deep, the roots of the weeds are only turned over and removed, and hardly ever thrown upon the ſurface to wither; but clean, ſhallow ploughing diſlodges and deſtroys them much more effectually. Nay, hand-hoeing is, he remarks, allowed by every body to do more towards cleaning land than a ploughing. And even the practice of burn-baking, he contends, effectually cleans land, though it only goes two inches deep. This ſeems, he ſays, to ſhew that very deep ploughing is by no means neceſſary towards cleaning land: and it muſt, he thinks, be univerſally allowed, that the longer we keep our manure within three or four inches of the ſurface the better; eſpecially upon a light ſoil, from which it is apt to ſink, and eſcape too ſoon *. And doctor Anderſon, who has had much experience in this way, informs us, that though benefits may be derived from the opening up of the ſoil to a conſiderable depth in ſome caſes, it is by no means neceſſary to attempt to plough, on ordinary occaſions, to a great depth: on the contrary, unleſs it be for very particular purpoſes, he is ſatisfied that ſhallow ploughing will, for the moſt part, be more beneficial than the reverſe. In that caſe the ſurface ſoil, in which all ſeeds muſt germinate, and draw their nouriſhment for a conſiderable period of their growth, will, he conceives, be rendered much more fertile by the ſame quantity of manure, than if it were mixed with a much greater depth of mold; and as it is known that the fertilizing qualities of all manures are carried downward by moiſture, where the ſoil is ſo porous as to admit of a ſlow abſorption of that water, the under-ſoil will gradually become more fertile by this proceſs, which will tend to nouriſh the crop. On retentive ſoils, where the practice of looſening them to ſome depth by other implements is omitted, deep ploughing is, however, he conceives, extremely neceſſary.

* Kent's Hints.

It is further remarked by the firſt author, that upon all light ſoils it is neceſſary to preſe ve, at ſix or eight inches below the ſurface, what farmers call a *pan*; that is, the ſtaple, at that depth, ſhould be kept unbroken; by which means manure will be kept longer on the top: and in dry ſeaſons the leſs depth the pan has, the leſs liable the corn will be to burn, provided the pan conſiſts of earth, and not of rock; becauſe the roots of the corn will, he thinks, find more moiſture by ſtriking againſt a body of cloſe earth than they will in a greater depth of hollow earth; as it is evident the former preſerves more moiſture in dry ſeaſons. And that another advantage which is obtained from this pan is, he conceives, the having a leſs quantity of mold to work and keep in heart. Where very deep ploughing is practiſed, this bottom, or pan, muſt be deſtroyed; and much more manure will be required in that caſe, he ſuppoſes, to keep the ground in good condition, and fit for the growth of crops.

In regard to the frequency of ploughing or turning over ground, in order to prepare and render it ſuitable for the production of good crops, it is obvious there muſt be much difference according to the nature and condition of the ſoil, as well as the kind of crop that is to be grown. The ſtiff, clayey, loamy, and even chalky ſoils will, in general, ſtand in need of more frequent ſtirring, either by means of the plough, harrow, or ſome other implement, in order to ſeparate and break down their tenacious particles, than thoſe of the ſandy or gravelly, and more light kinds, in which there is much leſs adheſion. Beſides, where lands have been in a courſe of tillage for ſome length of time, whether they are of a clayey, loamy, or even ſandy quality, they may require leſs frequent ſtirring than where the contrary is the caſe. And where the method of putting the ſeed into the ground by means of drill machines is to be had recourſe to, a fine ſtate of tilth will, in general, be indiſpenſably neceſſary.

The nature of the crop that is to be cultivated muſt, however, in moſt caſes, direct the number of ploughings that may be neceſſary, as ſome demand a much finer ſtate of tillage than others; though in moſt caſes a well-reduced earth is favourable. It has, indeed, been aſſerted, that the finer land of any kind is made by tillage, the richer and more capable of ſupporting plants it becomes. A proof of which may often be met with in lands where a part has, from accident or other cauſes, been better tilled than the reſt, as, though they be afterwards conſtantly managed in preciſely the ſame manner, the part ſo treated always affords better crops than thoſe which have not had the advantage of ſuch tillage *.

* Tull's Horſe-hoeing Huſbandry, 8vo. edit. p. 44.

Where the nature of the crop is ſuch as to be greatly retarded and injured in its growth, by the occurrence of other plants, as in wheat and barley, the land will conſtantly require to be rendered fine and mellow, either by frequent ſtirring by the plough, or the growing of ſuch preparatory crops as have a tendency to bring it into a friable and clean ſtate, by the ſhade which they produce, and the repeated tillage and culture which they receive while growing. And where ſuch plants as produce large, knobby, or tap roots, in or upon the ſoil, are to be grown, it will be neceſſary to have the land well broken down, and rendered mellow by repeated turning over, in order that they may more readily puſh down, or extend themſelves in other directions. Beſides, it has been ſeen that a fine ſtate of tilth is always the moſt favourable for affording the nouriſhment and ſupport of crops in a fre e and equal manner*, both on account of its admitting the fibrous roots of the plants to ſpread and extend themſelves with more facility, and the manures to become more minutely divided, and more intimately blended with the ſoils; as well as from the ſubſtances that conſtitute the food of the plants being more readily and more copiouſly formed by the chemical combinations and decompoſitions that take place under ſuch circumſtances. And further, by means of ſuch degrees of pulveriſation and mellowneſs, the ſeed, eſpecially when it is of the ſmaller kind, is not only more equally and more perfectly covered, but its vegetation more quick, from its becoming more fully in contact with the mold, and from the moiſture being more minutely diffuſed and retained in the ground, which is an advantage of much importance in the cultivation of many ſorts of crops.

In the choice of implements for the performance of this buſineſs, the agricultor ſhould be careful that they are well ſuited to the nature and quality of the land, as it is not poſſible that any particular ſort of plough can be employed with equal facility and advantage on ſoils of different deſcriptions. The clayey, and all the more ſtiff and heavy kinds of land, will require ploughs of more ſtrength than thoſe of the thin chalky, and a light, ſandy, or gravelly nature. The former may moſtly be managed in a proper manner by any of the well-conſtructed kinds of ſtrong ploughs, as the *Suffolk iron ſwing-plough*, &c. and the latter by thoſe of the light ſort, as the *Rotheram plough*, *Small's chain-plough*, &c †. But whatever deſcription of plough may be had recourſe to, it is a matter of the greateſt conſequence that it be properly formed and attached to the draught, as where theſe points are not minutely attended to, there muſt conſtantly be

* See ſection on Fallowing of Land. † See ſection on Implements.

a conſiderable loſs in the economy of labour and time, as well as in the completeneſs of the work. With ſuch ploughs as have a ſuitable form and conſtruction for paſſing through the earth without affording unneceſſary reſiſtance, any of even the heavier ſorts of ſoil may be ploughed with little more than half the ſtrength of team that is employed where the contrary is the caſe. It has been lately found, that in a light loamy ſoil, Small's plough, with two horſes a-breaſt, and the ploughman driving by means of rope reins, was capable of performing its buſineſs with equal readineſs, and to a greater depth when requiſite, than the ordinary ploughs of the diſtrict with four horſes, a ploughman, and a boy as a driver. This advantage, it is conceived, ariſes from the "ſymmetry of its parts, and the formation of the mold-board, which is of caſt-iron, and ſo conſtructed as to afford the leaſt poſſible reſiſtance in paſſing through the earth; and in giving the horſes the greateſt purchaſe in their draught, by placing them near the plough *." But it is remarked further, that "the leaſt variation in the formation of the mold-board, or in the proportional diſtance of the reſpective parts," is capable of deſtroying the effect; which further proves the neceſſity of cloſely attending to what has been mentioned above.

Harrowing.—This is a proceſs in tillage that becomes uſeful after ploughing has been performed, both with the view of breaking down and reducing the particles of the ſoil, ſo as to aid the pulveriſation that has been effected by the plough, and that of dragging out and clearing the land from root and other weeds that may have commenced their growth, as well as for the purpoſe of covering the ſeed.

In the two firſt intentions the ſize and weight of the harrows, and the length of the tines, or teeth, ſhould in moſt caſes be conſiderably greater than where the covering of the ſeed forms the principal object. And where the land has been laid in a rough manner by the plough, and there are many weeds of the root kind, it will be more advantageous and effectual to have harrows paſſing in a direction contrary to that in which the ground has been ploughed, as by that means more weeds will not only be eradicated, but the parts of the ſoil be more fully and more completely divided, broken down, and reduced. And where ſeed-weeds are to be eradicated, the ſurface ſhould conſtantly be, at firſt, made as fine and ſmooth as the nature of the land will admit, by harrowing, to promote their more rapid vegetation, in order that the ſubſequent operations of the ſame kind may clear the land in a more perfect manner. Drags, ſcari-

* Campbell in Communications to the Board of Agriculture, vol. III. p. 233.

fiers, ſcufflers, cultivators, and what are termed fixed harrows, are often very effective implements in theſe different intentions where the ſoils are of the more ſtiff and obſtinate qualities. Tines of different conſtructions, according to the circumſtances of the land, are alſo ſometimes employed with conſiderable benefit, in breaking and reducing the hard and cloddy condition of very tenacious and ſtubborn ſoils that have much of the clayey or ſtrong loamy property.

Where the deſign of the farmer is only to have the ſeed covered by the operation of harrowing, it will not be leſs neceſſary to have the ſurface part of the ſoil, after the ſeed has been ſown, rendered as fine and mellow as the quality of the land will allow, as where this is neglected the moiſture is not ſo perfectly diffuſed through or retained in the mold, nor the nouriſhment ſo equally ſupplied, conſequently the vegetation and growth of the crop muſt be more ſlow and imperfect. It is however remarked, by an intelligent writer, that though "it is obvious that ſtrong land requires more harrowing, in order to reduce it to a pulveriſed ſtate, than lighter ſoils; yet as all ſoils are rendered more firm and ſolid by harrowing, the leſs a ſtrong ſoil is harrowed, if the intention is anſwered, the better. On the other hand, light ſpongy ſoils, eſpecially where there is any portion of moſs (peat), being rendered more compact and retentive of moiſture by harrowing, can ſcarcely get too much *."

It ſhould likewiſe be noticed, that in all the more heavy and retentive kinds of ſoil, operations of this ſort, as well as thoſe of ploughing, ſhould be as little as poſſible performed when the ſeaſon is inclined to be wet; while in all thoſe which are of a ſandy, or open, porous nature, they ſhould be practiſed as ſparingly as the circumſtances of the caſes will admit, when it is very hot and dry; as in the firſt, great injury and diſadvantage muſt ariſe from their poaching, and becoming mortary; and in the latter from the too great evaporation and diſſipation of moiſture.

In reſpect to the manner of performing the proceſs of harrowing, when the ſeed has been ſown, the common method, according to the author juſt mentioned, is firſt along the ridges, then acroſs, and then along again. When the ridges are level, or nearly ſo, they may, he obſerves, be harrowed either way as the farmer may find moſt convenient, it being of little conſequence whether the harrow go firſt acroſs or along the ridges of a well-ploughed field in proper tilth; but if the ridges are raiſed in the middle, and the land indifferently ploughed, it would be highly improper to begin by harrowing acroſs,

* Donaldſon's Modern Agriculture, vol. I. p. 51.

as thereby a conſiderable ſhare of the ſeeds would fall into the bottoms of the furrows, and be prevented from vegetating.

There is ſtill another circumſtance, he remarks, in regard to harrowing, which, as it is frequently of very material importance, ought not to be omitted. It often happens, that after a field has been properly ſummer-fallowed, manured, and prepared in the beſt manner for ſowing wheat, the farmer is prevented from ſo doing by heavy falls of rain. Though no water may appear on the field, yet it is rendered ſo poachy, that he cannot put on his horſes for the purpoſe of harrowing in the ſeed, and that circumſtance alone prevents him from ſowing his wheat in due ſeaſon. In ſome parts of Scotland a method has been tried to remedy this inconvenience; which, when the ridges are ſtraight, and not over broad or too high raiſed on the crown, has, he ſays, been found to anſwer beyond every expectation that could be formed. It is as follows: An axle, equal in length to the breadth of the ridge, is fixed on two cart-wheels; and to this axle is chained as many harrows as will cover the breadth of the ridge. To each of the ends of the axle two horſes are yoked, and made to walk along in the furrows of the ridge; the wheels turning eaſily round, and following the horſes in the furrows: the horſes feet are, by this expedient, prevented from doing any injury, and the ſeed is as effectually covered as in the ordinary way. It is neceſſary, however, he ſays, that the harrows ſhould not be turned ſhort at the end of the ridge. But, to avoid confuſion, it is better to go along one ridge, and return by another, which may be done as often as is judged requiſite for harrowing the field in a ſufficient manner.

But though crops may, by contrivances of this nature, be put into the ground in the moſt proper ſeaſon, under ſuch circumſtances, they muſt often be liable to great injury, or even deſtruction, from the abundant wetneſs; it would probably, therefore, be a better practice to have the lands prepared ſo early as that the opportunity of a dry time might be afforded for harrowing in the ſeed in the ordinary way.

When graſs ſeeds are ſown, the operation of harrowing ſhould be performed only in a ſlight manner, and with a very light harrow, that has ſhort tines or teeth; as where theſe circumſtances are not regarded, they will be liable to be put in too deep, and their vegetation of courſe greatly retarded, if not wholly prevented.

Rolling.—This is another operation in the tilling of land, that is equally employed for breaking down and reducing the ſoil to a fine ſtate of tillage, and for levelling and rendering it ſmooth, after the ſeed has been harrowed in. In

the ſtiff, heavy, and adheſive ſoils of different kinds, the roller may frequently be made uſe of, in the firſt intention, with very great advantage; but it ſhould only be employed when ſuch lands are tolerably dry, for when drawn over the ground under the contrary circumſtances, little benefit can be afforded in the way of pulveriſation, while much miſchief muſt be produced by the poaching of the horſes, and the plaſtering of the earth round the implement. But by uſing it in the manner juſt directed, all the lumpy or cloddy parts of the ſurface ſoil may be effectually cruſhed and reduced into a fine powdery ſtate, fit for the reception of the ſeed. Or if in ſuch ſorts of ſoil it be applied in the intervals between the different harrowings, it may contribute much in the ſame way, not merely by reducing a great number of the lumps by the preſſure that it cauſes, but by forcing others ſo much into the ground that they may be acted upon and further broken down by the fermentation that moſtly takes place in the ſoil after land has been ſtirred. In all the light and more porous ſorts of ſoil, very beneficial conſequences may alſo be derived from this operation, by the conſolidation of ſurface that is thus produced, and the more perfect retention of moiſture, by which the ſeed, eſpecially if of the ſmall kind, is enabled to vegetate more equally, as well as in a more expeditious manner.

In caſes where land has been left rough after ploughing, for the purpoſe of more effectually deſtroying root weeds, it may alſo be of utility, by being employed before the harrows, to give them more power in laying hold of and reducing the ſoil. And by the pulveriſation that it affords, and the more perfect retention of moiſture that it cauſes in conſequence of the ſurface being rendered more cloſe and compact, the ſeed-weeds are produced more abundantly, and more readily deſtroyed. It is likewiſe in theſe laſt methods that it proves ſo highly beneficial in all caſes where graſs ſeeds are ſown; as well as by the equality and ſmoothneſs of ſurface that is thereby produced*. It is well obſerved, by the ſame writer, that if no other benefit were derived from rolling lands in tillage than ſmoothing the ſurface, even that in harveſt is of material conſequence, more eſpecially where the crops are cut down with the ſcythe, which is general in moſt of the ſouthern diſtricts of the kingdom, and which the increaſing ſcarcity of labourers muſt ſoon, in all probability, introduce into thoſe of the north.

Manuring.—In the application of manures to lands in the ſtate of tillage, conſtant attention will not only be neceſſary to the nature and quality of

* Modern Agriculture, vol. III. p. 55.

the ſoil and manure, but to the kind of crop that is to be grown with it, and the ſeaſon of the year, as well as the manner of its being laid on the land. Without proper management in all theſe reſpects, much expence and waſte of manure may often be incurred to little or no advantage. For, from what has been already advanced, it is ſufficiently evident, that ſome particular ſorts of manures are better ſuited, and more capable of producing beneficial effects on ſome kinds of land than others*. Thus, on the ſtrong, clayey, or loamy ſoils, thoſe of the animal or dung kinds, and which are capable of affording large proportions of ammonia or carbonaceous matter in proportion to their bulks, and ſuch ſubſtances of the calcareous kind, whether burnt into lime, or uſed in their natural ſtate, as are the moſt friable, or have the leaſt tendency to bind and cement the particles of ſoils together, are the moſt ſuitable and proper. And other matters, ſuch as ſand, and many ſimilar bodies, that are capable of dividing and ſeparating the parts of ſuch ſtiff ſorts of land, may frequently be employed with great benefit in the view of altering the conſtitution and texture of them mechanically, though they poſſeſs little virtue in the way of manures. But thoſe kinds of materials that have any great diſpoſition to increaſe the ſtiffneſs and tenacity of the ſoils, muſt be carefully avoided. Hence clayey marle, and all the more ſtiff and tenacious earthy ſubſtances, as well as what are termed by farmers the hot ſorts of lime, are in ſuch caſes diſadvantageous and improper for the purpoſes of manure

Where ſand is employed on ſoils of this deſcription, it ſhould be laid on them where convenient, in proportions ſuitable to the tenacity and ſtiffneſs of the land, and under ſuch circumſtances of tillage as that it may be the moſt capable of being minutely blended with it.

The common ſand can, however, only be laid upon lands with the view of its altering their textures, ſo as to render them more mellow and proper for the growth of grain crops. Sea ſand will be found highly beneficial, not only in this view, but likewiſe in conveying a portion of fertility. But, from the ſaline matters that it may contain, it may be either laid immediately on the land, or be mixed with dung and other manures into a compoſt before this is done, according to the circumſtances under which it is laid on.

On the perfectly loamy ſoils, eſpecially where they are of the mellow and more friable deſcription, almoſt every ſort of manure that is produced on the farm may be made uſe of with benefit. But where they approach much towards the

* Section on Manures.

ſtiffneſs of the heavier ſorts of ſoils, clayey marles may be improper, and where they abound with calcareous matters, lime, chalk, and other ſubſtances of the ſame kind, ſhould be leſs freely employed.

In the application of manure to lands of the *marſhy* kind, when they are brought into a ſtate of aration, ſimilar attention will likewiſe be neceſſary. It has been obſerved, that where theſe ſoils are compoſed of a heavy, moiſt ſleech, a very ſluggiſh ſpecies of land is formed, on which the crop is lodged from year to year, before it arrives at maturity, which makes it of little value. A quantity of ſand from the beds of rivers, when laid on ſuch ſoils, enables them, however, to produce excellent crops of lump grain, which ſtands until they are cut down *.

But on the ſandy and all the lighter ſorts of tillage lands, ſuch manures as poſſeſs the property of promoting and augmenting the tenacity, or of bringing the particles more cloſely together, of retaining moiſture, and of affording ſtability to the roots of plants, will be the moſt favourable. In theſe views, clayey marle, the ſediments and depoſitions of ponds or rivers, loamy and peaty earths, &c. with farm-yard dung, may be had recourſe to with propriety.

In Suffolk, on the ſandy diſtricts, the earthy ſubſtance applied is generally a clay marle; though a pure, or nearly a pure clay, is preferred to very looſe ſands. But when the *clay* is not of a good ſort, that is, when there is none, or ſcarcely any clay in it, but it is an imperfect, and even a hard chalk, there are great doubts how far it anſwers, and in many caſes it has been ſpread to little or no advantage. The quantity uſual is from ſixty to eighty, and ſometimes one hundred loads an acre, the load containing about thirty-two buſhels. Many experienced farmers, however, prefer carrying forty or fifty loads only, and repeating it after the firſt courſe. The beſt mode of doing it, according to ſome, is to lay down the land with graſs-ſeeds for a couple of years, and then lay the clay upon the turf the latter end of the ſummer, and break up the land in the ſpring following, to ſet with peaſe, if the land be proper for that crop. It is, indeed, conceived, that one hundred loads per acre are, perhaps, not too much for newly cultivated heaths or warrens. But for other fleet ſoils, which have been for a long time under cultivation, fifty, or at moſt ſeventy loads, are quite ſufficient.—On ſuch ſoils, to lay on too much is attended with great loſs. In this way the land receives more immediate benefit, and double the number of acres may be clayed in the firſt

* Agricultural Survey of the County of Perth.

years of the farmer's leaſe, without any additional expence*. The duration, and indeed the whole effect, it is obſerved, depends much on the courſe of crops purſued. If the plough be too freely uſed, and corn ſown too often, it anſwers badly, and the effect is ſoon loſt; but with good management it laſts twenty years. Where the management is good, and the clay well adapted to the land, the profit is alſo very great. In many caſes a courſe of fallow and rye, or *light* oats, is converted to fine barley, clover, and wheat, and the produce of the ſoil multiplied twenty-fold; but, on the contrary, the caſes in which the return has been inadequate, are not a few. And it is believed that it will be found, that on ſoils that will yield ſaintfoin, it is more profitable to cultivate graſs, than to clay the land for corn. There are various ſorts of clay in uſe; ſome ſo exceedingly ſtrong and loamy, that they will not mix with the ſoil; others ſtrong and full of particles of chalk; and another ſort very tender, and which has a mixture of ſand: the ſecond is believed to be the beſt; the uſe of it prevails very much at preſent, in the ſtrong wet lands in high Suffolk, even where *clay* is ploughed up. Within a few years, the mixing clay with maiden earth and muck out of the farm-yards is very much practiſed; and good farmers tell you, that muck ſhould never be carried upon the land alone: the reaſon of which it is ſaid is, that muck produces ſtraw with little corn; but to grow a full crop of corn, compoſt muſt be uſed †.

It is alſo ſaid to be a great improvement in the applying of clay, or marle, to lands, to make uſe of ſingle-horſe carts, inſtead of the common tumbril, or heavy cart. Calcareous materials, both in their pulveriſed raw ſtate, and that of calcination, may in many inſtances alſo be applied to ſoils of the above deſcription, with very beneficial conſequences.

It has, however, been well obſerved, that previous to the application of either chalk, lime, or gypſum, particular attention ſhould be paid to the nature of the ſand. If it ſhould appear to owe its origin to lime-ſtone, marble, ſhells, or other ſuſtances that admit of being burnt into lime, the addition of calcareous matter would, in moſt caſes, be uſeleſs. At all events, the application of theſe ſubſtances ſhould be firſt made on a ſmall ſcale, in order to aſcertain the effects they would produce ‡.

Moſs or peat earth, either in a ſtate of combination with farm-yard dung or

* In regard to the expence of this application, it is obſerved, that the men are paid from 27s. to 30s. per one hundred and twenty loads, for filling and ſpreading, earning 10s. or 11s. a-week; and the expence of teams is about as much more. When this manuring is done, therefore, on very poor land, the expence is nearly equal to the value of the fee-ſimple of the eſtate.

† Agricultural Survey of the County of Suffolk. ‡ See Middleton's Report of Middleſex, p. 145.

in its natural ſtate, has likewiſe been found highly uſeful. Upon light land, where there is a great proportion of ſand or gravel, the moſſy material naturally retains the rain and the dew, which that kind of ſoil could not naturally retain; and by this ſupply of moiſture, preſerves ſuch dry ſoils from the effects of ſevere drought. After it is ploughed in, it likewiſe not only acts as a ſponge, but forms an addition to the ſtaple of the land, which are circumſtances not to be diſregarded in the uſe of manures*. The manure produced by the turning in of ſucculent green vegetable-crops, may alſo ſometimes in ſoils of this kind be attended with ſucceſs.

In the arable management of peaty, moſſy, or moory ſoils, the moſt advantageous application in the way of manure in the firſt inſtance will, in general, be that of lime, or ſome other of the ſubſtances that abound in calcareous matter, in large proportions, together with the aſhes that have been formed where the practice of paring and burning has been adopted in bringing them into cultivation. And after theſe have been well incorporated with the ſoil, farm-yard dung, where it can be procured, may be had recourſe to with great benefit. Clay, ſand, gravel, and various earthy ſubſtances of a ſimilar nature, may alſo often be made uſe of on ſuch ſoils with great utility in the way of rendering them more firm, and giving them greater compactneſs of texture†.

In the uſe of manures, beſides adapting them to the nature and properties of the ſoils, the agricultor ſhould be careful to apply them in ſuch ways as may be moſt ſuitable for the production of their fulleſt effects. In this view, the nature of the crop, the condition of the manure, and the mode of its application, are to be well conſidered; for it has been found from practical trials, that where particular ſorts of manure have either been naturally found in the ſoils, or artificially laid upon them, ſome kinds of crops may be grown and brought to perfection much more completely than where ſuch impregnations have not taken place; while on the contrary, other ſorts of crops can ſcarcely be produced at all until a different ſort of manure has been incorporated with the mold. Thus it is obſerved that the common pea, whether white or grey, cannot be reared to perfection in any field which has not been either naturally or artificially impregnated with ſome *calcareous* matter. And hence it is ſuppoſed to happen, that peas are rarely cultivated univerſally as a field crop, unleſs in thoſe parts of the country where either lime, marle, or chalk abounds, or upon ſtrong clays: except, indeed, on the ſea coaſt, where ſhell-fiſh are often catched in abundance, and where the fields are manured with their ſhells in a ſtate of mixture with dung. But it is remarkable, that a ſoil that could

* Agricultural Survey of Perthſhire, p. 297. † Ibid. 298.

ſcarcely have brought one pea to perfection, although richly manured with dung, from their running too much to haum, and, after bloſſoming, dying away without becoming ripe, if it has once had lime applied upon it, is capable, when properly prepared in other reſpects, of producing plentiful crops of peas ever afterwards *. It is further remarked by the ſame writer, on the reſult of an experiment, in which the ridge of a field that had been miſſed in liming produced no good wheat, while all the other parts afforded a full crop, that lime, or ſome other calcareous material, is equally neceſſary for the production of good wheat crops as for thoſe of the pea kind. The general obſervation that the wheat, where this ſort of manure has been employed, is thinner in the ſkin, more plump, and yields better, ſeems alſo to favour the ſame concluſion. Impregnations of this ſort appear likewiſe, it is ſuppoſed, particularly favourable for the production of barley crops, much more ſo, eſpecially if in large proportions, than for thoſe of oats.

But, on the contrary, turnip crops are found to be produced in the beſt manner where the land has been enriched by means of dung; while lime, or other calcareous ſubſtances, do not promote their growth in nearly ſo high a degree. This is alſo in ſome meaſure the caſe with cabbage, potatoe, and other crops of a ſimilar kind. Hence it is concluded by the author juſt mentioned, that turnips are the moſt ſuitable for firſt improving crops in ſuch diſtricts as are deſtitute of calcareous matter, and peas in thoſe which abound with it.

As in the cultivation of different ſorts of crops there are ſome that require large ſupplies of nouriſhment during the more early ſtages of their growth, while others demand ſmaller proportions, but to be continued with great regularity and evenneſs for a conſiderable length of time, it will be proper and advantageous to apply the manures in ſuch ſtates as may be the moſt favourable for theſe purpoſes. Thus, where thoſe ſorts of luxuriant crops that ſtand in need of much ſupport in their early growth, ſuch as potatoes, cabbages, turnips, carrots, peas, beans, and other ſimilar ones, they ſhould not only be laid upon the land in a leſs reduced ſtate, eſpecially where the lands are light, but be applied in ſuch a manner as that the crops may derive the benefit of them in the moſt full, equal, and expeditious manner. Hence in the two firſt, as well, perhaps, as in ſome of the other kinds, it may be the moſt beneficial method to place it in drills with the ſets or plants, and in the latter to be lightly ploughed, harrowed, or otherwiſe put in, immediately before the ſeed is ſown. But as in the turnip, and other ſimilar crops, from the ſmallneſs of the ſeed, and

* Anderſon's Eſſays, vol. II. p. 302.

other circumſtances, a much finer ſtate of ſurface is neceſſary than for the other kinds, it may be proper, eſpecially where the manure is only harrowed in, to have it ſhorter and more rotten than in the other caſes. It has alſo been remarked, that by depoſiting the manures in drills, much advantage will be derived in the ſaving of ſuch articles, as well as in the crops' being more effectually ſupported, and conſequently more productive. Beſides, the manures in this way are more completely ſecured againſt the effects of evaporation *.

In the application of manure for grain crops, as they are frequently liable, eſpecially in the better ſorts of ſoils, to be greatly injured by an over-luxuriant growth, where the dreſſings are laid on for the immediate crop, it may be a better practice in ſuch caſes to have them applied with the different preparatory fallow, or green crops, ſuch as turnips, peas, beans, cabbages, carrots, &c. as in this way great advantages will be obtained, not only in the production of ſuch crops, and their bringing the lands into the moſt perfect order for the growing of grain, but in the manures being more fully and more completely blended and incorporated with the ſoils. Where the quality of the land is not very good, and the method of ſummer fallowing is purſued, it may, however, in ſome inſtances, be a good method to apply the manures upon the fallows, both for the wheat and barley crops; as under ſuch circumſtances of the land, it is probable they are moſt capable of being minutely blended with the ſoil, and conſequently of affording the moſt equal ſupport to the grain. Where calcareous ſubſtances, ſuch as fine chalk and the ſhell marles, are to be made uſe of, it may alſo be the moſt ſuitable method to apply them when the lands have been reduced to a conſiderable degree of pulveriſation and fineneſs, by ploughing, or other means; as under ſuch circumſtances they will be much better and more minutely divided and incorporated with the mold of the ſoils than could otherwiſe be the caſe, a point on which we have ſeen that much advantage depends in the application of ſuch matters. Such materials are frequently laid on the land in their ſimple ſtates, and in making uſe of them at firſt upon a ſoil, it may be the moſt beneficial method; but where they are often repeated, the practice of mixing them with earthy or other ſubſtances may be more advantageous †.

But in whatever way or on whatever deſcription of tillage land the manure of the farm may be principally applied, it ſhould never at firſt be depoſited, or covered up too deeply, in the ſoil; as where a large maſs of earthy matter is placed upon the manure, the effects are not only much ſlower, but liable to be

* Experienced Farmer, vol. I. † Section on Manures.

exerted when they cannot be of the moſt utility in aiding the growth of the crops. Beſides, as moſt of the ſubſtances employed in this way have much tendency to ſink down to the inferior and more ſolid parts of the ſoils below by the rains, and the neceſſary hoeing and ſtirring that muſt ſucceed, they will be ſooner out of the reach of the abſorbent roots of the plants which they are deſtined to ſupport, which for the moſt part only extend themſelves in a ſuperficial manner. They ſhould, however, in every caſe, be ſo covered or placed in the earth, as that the diſſipating proceſs of evaporation may be effectually guarded againſt.

In regulating the proportions or quantities in which manures ought to be applied to lands under the ſtate of tillage, various circumſtances are to be taken into conſideration, ſuch as the nature, ſituation, and condition of the land, the manner in which it has been previouſly employed, the kind of crop that is to be grown, and the ſtrength or goodneſs of the manure to be applied. In bringing different ſorts of land into cultivation, where they are naturally poor and thin in the ſtaple, or where they have been much reduced and exhauſted by injudicious modes of cropping, as well as where full crops of thoſe luxuriant vegetables that require much ſupport are to be cultivated, it will, in general, be the beſt practice to apply ſuch full dreſſings at once, as may be ſufficient to bring the lands into ſome ſtate of richneſs and improvement, and at the ſame time render them capable of ſuſtaining the crops that may be put upon them; as where ſmall quantities are only laid on at once in ſuch caſes, much loſs is moſtly ſuſtained in the poverty of the crops, as well as in the great length of time that is required to bring the lands into a ſuitable condition for the purpoſes of tillage.

In the applying of different ſorts of dung, and all thoſe manures that are in a ſuitable condition for immediately imparting to the earth ſuch ſubſtances as are proper for the nutrition and ſupport of crops, eſpecially where the principal object of the agricultor is the benefiting of grain, or ſuch other ſorts of crops as may be directly cultivated, and not that of the more diſtant advantage and improvement of the ſoil, conſiderable ſavings in the quantities of the manures may probably often be made, by laying them upon the land and blending them with the mold as nearly as poſſible to the periods of ſowing or putting in the crops; as in this way there will be but little loſs from the diſſipation or waſhing away of the nutritious matters before the crops are in a ſtate to be benefited by them, as muſt always be the caſe to a greater degree than is, perhaps, generally ſuppoſed, where the contrary practice is purſued. In this method, they may be employed with

great propriety to the wheat, barley, pea, or turnip crops, by being equally ſpread out upon the prepared land, and then turned into it by means of the ſeed furrow, which in ſuch caſes ſhould in general be very light, or only ſuch as is juſt neceſſary to cover them well.

The quantity of manures of this kind that will uſually be requiſite to be laid upon land under ſuch circumſtances, though it muſt vary conſiderably according to the ſtate of the ſoil, and the goodneſs of the dung, will, in general, be from about fifteen or ſixteen to twenty tons the ſtatute acre. Where, however, the main object of the farmer is that of bringing the land into a proper ſtate of cultivation, or that of affording a conſiderable degree of amelioration and improvement, it will often be neceſſary to have recourſe to much larger quantities if it be poſſible to procure them.

In turning down clover, or other new lays, where there is a conſiderable proportion of vegetable matter upon the ſurface, with the view of ſowing wheat or other crops upon them, it will ſeldom, perhaps, be requiſite to have recourſe to ſuch full dungings as may be proper under other circumſtances; but in all ſuch caſes the manures ſhould not be turned into them to too great a depth, as where that is done the immediate crop will often derive little or no benefit from ſuch dreſſings.

But in whatever method, and in whatever proportions, manure of the dung kinds may be employed, it ſhould always be ſpread out with as much evenneſs as poſſible, and be turned into the ſoil as ſoon afterwards as the work can be performed with facility. In conveniently accompliſhing theſe points, it will be neceſſary to depoſit it upon the land in ſmall heaps, and not to have too much carried out at a time; as by the firſt method the ſpreading may be effected with much greater exactneſs, and by the latter, the whole may be turned into the ſoil ſo quickly after its application as to prevent the waſte ariſing from evaporation, or the effects of rain, circumſtances of great conſequence where manures may be applied either in very dry or rainy ſeaſons.

But where ſubſtances of the calcareous kinds, ſuch as lime, chalk, marle, ſhelly matters, and even ſea or other ſorts of ſand, are to be made uſe of in the way of manures to tillage lands, as much of their beneficial effects evidently proceeds from their being very minutely blended with the particles of the ſoils, they may be applied with the greateſt chance of advantage where the lands are undergoing the culture of repeated ploughing, as in fallowing for wheat, turnips, &c. for in ſuch circumſtances their parts are in the greateſt ſtate of diviſion, or what by farmers is moſtly termed mellowneſs, and of courſe in the

moſt ſuitable condition for admitting the particles of ſuch materials to be the moſt evenly blended and incorporated with them. In this intention, theſe ſorts of materials ſhould always be ſet on in ſuch a manner, and be in ſuch fine ſtates of pulveriſation, as that they may be ſpread out upon the lands very equally. By chooſing a rather dry ſeaſon for the buſineſs, and depoſiting the ſubſtances in ſmall heaps along the ridges of the fields, ſuch work may, in general, be well and conveniently executed.

It is obvious, from what has been already advanced concerning the nature and operation of theſe ſorts of manures, that they muſt be uſed in different quantities or proportions, according to their qualities, and the differences in the ſoils *. It is, however, the common practice to apply a larger quantity to the heavy and ſtiff ſorts of land than to thoſe of the lighter kinds. Lime is uſed in different diſtricts at the rate of from one to four or five hundred buſhels, in proportion as the ſoils ſeem to ſtand in need of it. Chalk, in its calcined ſtate, is employed in the proportion of from one to two hundred buſhels, and in its crude ſtate to a much larger extent. Marle and ſea or other ſorts of ſand are laid on in various proportions from one to two thouſand buſhels, and in many caſes even conſiderably more †. When uſed on tillage lands, marle ſhould always be well broken down and reduced, as without this being duly attended to, but little benefit will often be produced.

Where lime, either from chalk or limeſtone, is made uſe of in repetition on the ſame land, it may frequently be more beneficial to employ it in the form of compoſt, with rich earths and other materials, than in its pure ſtate, as under ſuch circumſtances its effects in different caſes have been obſerved to be more beneficial. When made uſe of in ſuch a ſtate, the quantity laid on muſt, however, be conſiderably larger in proportion to the goodneſs of the ſubſtances that are blended with the lime.

In the applications of lime to the ſurface of coarſe ſorts of land, with the intention of breaking them up, and bringing them into the ſtate of tillage, much larger quantities than have been mentioned above may ſometimes be required, and which muſt be regulated by the nature and ſituation of ſuch lands, as has been already noticed.

Lime may alſo, ſometimes, be uſed on the wheat, turnip, or other crops, in the early ſpring months, eſpecially where danger from grubs, or other inſects, is apprehended. In ſuch caſes it is probably the beſt method to employ it in very fine powder, and in its cauſtic ſtate, ſowing it over the crops with as much

* See ſection on Manures. † Modern Agriculture, p. 204.

regularity as poſſible. This ſhould be performed when the weather is dry, as in a rainy ſeaſon injury might be done to the crops by the cauſtic properties of the lime. It may likewiſe be made uſe of in the ſame way, where no ſuch danger is feared, to promote the growth of the crop; but in ſuch caſes it is probably better to apply it in the ſtate of compoſt with ſome earthy ſubſtance, and in a larger proportion than in the former inſtance. The quantity in all theſe caſes muſt be regulated by the circumſtances of the ſoil and the crops.

In applying materials of the dung kind, or ſuch as contain ſaline matters, as aſhes, ſoot, &c. in this manner, it will alſo be neceſſary to have them reduced into a ſtate of fine powder, in order that they may be ſpread over the crops with regularity and evenneſs. The effects of ſubſtances of this ſort will alſo greater if they are ſown over the crops when the weather is inclined to be wet.

The uſe of ſubſtances that have been much reduced and broken down, by being thinly ſown, and ſpread out over the land by the hand, is a practice that may be more generally had recourſe to in ſituations where manures are ſcarce and expenſive, as in this way the growth of crops may be promoted with but a comparatively ſmall quantity of them. They are, however, much leſs conſtant in their effects than ſuch as are turned into the ſoil, and of courſe can only be employed for the immediate crop. Where permanent advantage and improvement are to be given, the more maſſy ſorts of manure, either of the animal, vegetable, or foſſil kinds, muſt be applied according to the ſtate and circumſtances of the ſoils.

Various materials may be made uſe of in the manner of top-dreſſings for arable land, ſuch as rags reduced by cutting or chopping to very ſmall pieces; rabbit, pigeon, and the dung of poultry in general; ſoot, the aſhes of wood, turf, peat, and coal; different animal matters, ſuch as horns, bones, hoofs, &c. after being brought to a coarſe powdery ſtate by grinding, or other means; the combs and duſt of malt, and the refuſe of various ſorts of ſeeds, ſuch as flax and rape, &c.

The rags are applied in various proportions according to circumſtances, from half a ton to a ton and a half, or more, being ſown over the land immediately before the laſt ploughing, when they are lightly turned in, and the ſeed ſown; their effects when uſed in this mode are often obſerved for ſeveral crops.

The dungs of rabbits, and different ſorts of birds, are moſtly employed for barley or turnip crops, in the proportion of about ſixteen or twenty ſacks to the acre, each ſack containing three buſhels, being thinly ſown over the land

after the laſt or ſeed-furrow has been given, and harrowed in with the ſeed. They are frequently alſo ſown on the young wheats and clovers in the ſpring, with great advantage; but when uſed in this way, they ſhould always be laid on very early, eſpecially on the drier ſorts of ſoil, as about the latter end of January; but on ſuch as are more wet, February, or even March, may be more proper. When their application is deferred to too late a period, there is often danger of their being leſs uſeful from the increaſing dryneſs of the ſeaſon, and their rendering the land, in ſome caſes, more apt to burn *.

Soot is chiefly laid upon the crops of wheat, ſaintfoin, and clover, that have had no previous manuring. It is uſually ſown over them with the hand, in the proportion of from twenty to thirty buſhels, or even more, to the acre, about January or February, having been collected into heaps during the winter for the purpoſe.

The vegetable aſhes, and thoſe of turf and peat, are likewiſe found uſeful to the young wheats and clovers, when ſown over them in the ſpring, in the ſame quantities as thoſe of ſoot; or a conſiderably leſs proportion of wood aſhes, as eight or ten buſhels, may be ſufficient. They may alſo be uſed on the turnip fallows with great benefit, being ſpread over them, and harrowed in with the ſeed. If ſown over the turnips in the early ſtages of their growth, wood aſhes are likewiſe ſaid to be beneficial in preſerving them from the ravages of the fly.

In Hertfordſhire, where theſe ſorts of dreſſings are, perhaps, more uſed than in any other diſtrict, the coal aſhes are principally employed on the clover crops, being bought from the different collectors of them in the county, or brought in back-carriage from London on taking the grain to the market during the winter ſeaſon, and ſown over them in the early ſpring. They are uſually laid on at the rate of about twenty or five-and-twenty ſacks of three buſhels each to the acre, and in this way are found of ſuch utility as to prove the practice highly economical, and deſerving of more general imitation by the agriculturs of other diſtricts †.

When ſoot and ſubſtances of the ſame ſort are had recourſe to, they ſhould invariably be preſerved in places conſtructed for the purpoſe, and covered over ſo as to protect them from the rain and wetheſs, as where this practice is neglected, the ſaline matters contained in them being diſſolved, are carried down and loſt, by which means their valuable properties are conſiderably diminiſhed. The cuſtom of laying them in large heaps in the fields expoſed to the weather,

* Synopſis of Huſbandry, p. 42. † Ibid. 43.

however convenient, ſhould therefore always be avoided by the attentive agricultor, as waſteful in a high degree.

Where bones, horn, hoofs, and other hard animal materials are to be made uſe of in this way, they are commonly ſown over the land in the quantity of from about half a ton to that of a ton to the acre, according as they are reduced or broken down, before the laſt ploughing, and immediately turned in with a light furrow. If too large a proportion of this manure be employed, the grain, it is ſaid, becomes too luxuriant, and too long in ripening, as well as liable to injury from mildew. When made uſe of in the more lumpy or unreduced ſtate, they ſhould be turned into the ſoil a greater length of time before the ſeed is ſown, in order that time may be given for them to undergo decompoſition, and impart their nutritious properties to the earth.

The combs and duſt of malt are commonly made uſe of, as a hand-dreſſing to the young wheat crops, and thoſe of barley, turnip, and clover. They are employed at the rate of from thirty to forty buſhels, or more. They are frequently ſown with barley and turnip crops, in Hertfordſhire, at the rate of about thirty buſhels to the acre, and harrowed in. This manure, like many others of thoſe applied in the ſame way, is found to be the moſt beneficial where ſown over the crops at ſuch periods as that their effects may be promoted by the ſucceeding rains.

The refuſe of oily ſeeds, when laid upon heavy ſorts of land in the manner of a top-dreſſing, is frequently blended with a little lime, as about ſix parts to one; but upon light or calcareous ſoils it may be uſed alone. It is uſually ſown over the wheat crops, at the rate of eight or ten buſhels to the acre, and in ſome places diſperſed over the lands in the ſtate of preparation for wheat or turnips, and then lightly turned into the ſoil. This is ſometimes the practice in the county of Norfolk. The uſe of cakes or the refuſe of this kind of ſeeds in the feeding of cattle, and other animals, has, however, of late, rendered it too expenſive to be much employed in the way of manure.

There are, probably, many other ſubſtances of ſimilar kinds to theſe that have been mentioned, that might be employed in this way, where there is a ſcarcity of other ſorts of manure, and in improving the ſickly and defective crops in the early ſpring months; but they have not yet been ſufficiently attended to by agricultors.

The expence of the application of manures in this way muſt obviouſly be very different according to ſituation and other circumſtances; but, in general, conſidering the great way they are made to go, and the readineſs and conve-

nience of their application, they may be ſaid to be cheap and economical*. By providing adequate ſupplies of theſe manures, it is aſſerted by the author of "Modern Agriculture," that the inconveniences of bad ſeed times and ſeaſons may, in a great meaſure, be obviated. And that as they are peculiarly adapted to the poor, light, ſandy, and gravelly kinds of ſoil, from which the ſpecifically heavieſt grain is produced, they may place them more on an equality in reſpect to their annual value, with thoſe of the ſtronger and richer ſorts. At all events, the increaſe in the practice of applying ſuch ſubſtances in thoſe diſtricts in which they have been long had recourſe to, ſufficiently, he thinks, juſtifies attempts of the ſame nature in others, eſpecially as ſuch kinds of materials may, in many ſituations, be procured with facility ‡.

In regard to the ſeaſon of applying manures to land in the ſtate of tillage, it muſt always depend in a great meaſure upon the convenience of the farmer, the ſtate of the ſoil, and the nature of the crops that are to be produced; but where theſe do not interfere, the diſſipating heats of the ſummer, and the waſhing effects of the winter and autumnal ſeaſons, ſhould as much as poſſible be avoided. For where they are laid upon the ground in the hot ſummer months, except they be immediately turned into the earth, a large proportion of their moſt beneficial properties muſt be forced off into the atmoſphere by the continued action of the heat, and be wholly loſt; and where they are applied in the more rainy periods of the winter, they muſt be liable to be diſſolved, and carried away into the ſurrounding ditches of the fields, or to ſuch a depth below the looſened mold, as to be of but little utility to the crops. The early ſpring, before the hot weather ſets in, and the latter end of ſummer, before the heavy rains begin to fall, and when the heat is becoming daily leſs, where the nature of the crops will admit, would probably be the moſt advan-

* It is ſtated by the author of The preſent State of Huſbandry in Great Britain, that the average price of top-dreſſings in Hertfordſhire, is as follows:

	£.	s.	d.
Thirty buſhels of ſoot, at 8d. is	1	0	0
Ditto of aſhes, the carriage being the principal expence,	0	10	0
Coal aſhes, ...	1	15	4†
Ten buſhels of oil-cake duſt, at 2s. 6d.	1	5	0
Forty buſhels of malt duſt, at 1s.	2	0	0
Fifteen buſhels of horn ſhavings, at 2s.	1	10	0§

† According to the author of the Synopſis of Huſbandry.

§ Editor of Miller's Dictionary.

‡ See Section on Manures.

tageous periods for their application, though the buſineſs is moſt commonly performed by farmers during the more vacant periods of the drying ſummer ſeaſon, and of the winter froſts *.

There are ſtill other means of improving arable lands, beſides thoſe of the direct application of thoſe ſubſtances that are properly termed manures; ſuch as thoſe of turning into the ſoil various kinds of green vegetable crops in the moſt ſucculent ſtages of their growth, the folding of ſheep on land, and the covering of the ground by the overflowings of rivers, or the tides of the ſea, &c.

Ploughing in green crops.—This is a method that has been employed in huſbandry for a very conſiderable length of time on the Continent, though it is but little practiſed by the farmers of this country. This, probably, ariſes in ſome meaſure from the ſoils being in moſt diſtricts too wet and heavy for its being had recourſe to with much advantage; the light and more friable kinds of land being the moſt adapted for improvement in this way, as in ſuch deſcriptions of ground the green materials undergo decompoſition much more readily, and become more readily in the proper ſtate for affording the nouriſhment and ſupport of crops. Indeed, in ſome of the clayey ſoils, the putrefaction of ſuch ſubſtances is retarded in ſuch a manner, that little or no benefit can be derived from them.

In ſoils ſuited to this method of manuring, crops of the green kind, ſuch as buck-wheat, tares, clover, rape, and, where ſown for the purpoſe, peas or beans, &c. might be turned in as a preparation for wheat crops, without the expence of fallowing. Where this practice is employed, the crops, as has been juſt obſerved, ſhould always be turned down when in their moſt luxuriant ſtages of growth, and the ſoil is rather dry, in order that a ſpeedy decompoſition and decay may take place. It is probable alſo, that advantages may be gained in this view by the application of ſmall proportions of calcareous ſubſtances in their cauſtic or more active ſtate over them before they are turned down †. The economy of this practice muſt chiefly depend upon the ſavings in cartage, and the labour of preparation, which in other ſorts of manure muſt always be conſiderable.

In ſome diſtricts ‡ this practice, after having been attempted, appears to have been given up from its not fully anſwering the purpoſes for which it was

* See Section on Manures. † Ibid.

‡ Young's Agricultural Survey of Lincolnſhire, p. 265.

intended, which in all probability was owing to the lands, in moſt caſes, being either too wet or too heavy to permit a full and complete putrefaction of the vegetable matters turned down.

Folding of ſheep on tillage land.—This method of improving tillage lands ſeems to have been practiſed from the moſt early periods of the art of agriculture, and to be ſtill had recourſe to in different diſtricts of the kingdom with the moſt beneficial and advantageous conſequences. It however can only be employed with much ſucceſs where the nature of the farm admits of the ſheep-huſbandry being carried to ſome extent in combination with that of arable cultivation; and where the ſoil is of ſuch a dry, mellow, and light porous quality, as to require to be rendered more ſolid and compact by the treading of the animals. In ſuch as are much loaded with moiſture, or are very ſtiff and heavy, it will be improper and injurious. The treading, in the laſt ſorts of land, tending to render them more cloſe and compact, they of courſe become more improper for the growth of moſt ſorts of crops by the practice.

As it is probable that much of the beneficial conſequences of this method of huſbandry in tillage lands, muſt proceed from the action of the ammonia formed from the urine and excrement of the ſheep, it is eaſy to ſuppoſe that moſſy or peaty ſoils, as containing much vegetable matter on which it can operate, may likewiſe be greatly improved in this way, as well as by the conſolidation of the land from the treading of the animals. It is, indeed, impoſſible to ſuppoſe that the whole of the advantage that is obtained in many caſes of this ſort of ſoil, by the folding of ſheep, can be produced ſolely in the latter mode.

The practice of folding may be uſefully employed on ſuch ſoils as we have ſeen to be proper for it, in the ſummer ſeaſon, either as a preparation for wheat or turnip crops, in which caſes the ſoil ſhould not by any means be ſtirred to any great depth in the ploughings that may be given after the folds have been formed, as by turning in the ſurface-mold that has been rendered rich and mellow by the proceſs, to a conſiderable depth, the good effects of the practice muſt obviouſly be in a great meaſure loſt. In many inſtances it may perhaps be the beſt method merely to harrow in the ſeed without any further uſe of the plough; or what is probably a ſtill better practice, eſpecially on very light ſoils, is that of folding the ſheep upon the land immediately after it has been ſown. In hot ſeaſons, the turning it in by a ſlight furrow, as preventing any loſs by evaporation, may, however, be right. Folding may alſo be had recourſe to in the ſpring months, both as a preparation for the barley crop, and as affording vigour and ſupport to the young wheats, eſpecially where the ſoils are ſo light as to endanger the crops from the looſeneſs of the mold about the roots. In the laſt method the ſheep muſt be

ſuffered to remain upon the land only a very ſhort time each day, and be put in at ſo early a period of the growth of the crops, that no injury can be produced by the pulling up of the plants in the feeding of the animals.

There is ſtill another method of folding, which is ſometimes made uſe of during the winter ſeaſon, where the lands are ſufficiently dry; this is that of confining the ſheep upon ſuch ſtubbles as are intended to be ploughed up in the ſpring. But in the firſt methods the folds ſhould not be nearly ſo extenſive as in the laſt; a flock of one hundred and fifty ewes and lambs being in the former modes confined on about four or five rods of ground, while in the latter they ought to have ten, fifteen, or even more*. The ſpaces of land on which they are confined may, however, be much varied, according to the circumſtances of the different caſes, and the purpoſes the agricultor has in view, but they ſhould always be ſuch as that the animals may not be inconvenienced by being too greatly crowded together, and that the improvement of the land may be fully effected. Where they are not ſo cloſely confined, they may be ſuffered to remain a greater length of time on the ſame ſpot, though in general it is by much the beſt practice only to confine them one night on the ſame ſpace of ground.

From the nature of this mode of manuring land, it muſt be obvious, as has been obſerved, that it can only be employed with much ſucceſs where there is a conſiderable extent of common, grazing, or paſture land, annexed to the arable; or where green crops, ſuch as turnips, tares, rape, and other plants of a ſimilar kind, are cultivated upon a pretty large ſcale. As where the ſheep have not ſuch deſcriptions of land to feed and fill themſelves well upon, the evacuations voided by them can only be ſuch as to afford a very ſlight improvement to the ground.

There are beſides theſe ſome other circumſtances to be attended to in the management of this buſineſs on arable lands. The ſheep ſhould conſtantly be kept as near as poſſible to the lands that are intended to be improved by the ſheep-fold, in order that no injury may be done to the animals, and that as little loſs as poſſible may be ſuſtained during the time they are in driving from the paſtures to the folds. In this view, ſuch a number of folds will be neceſſary as may allow the ſheep not to travel further than would be ſufficient for their feeding in other caſes, proper paſture or other lands being always provided for them as contiguous as may be to the grounds to be folded. In theſe it will alſo be an advantageous plan to keep them confined when the weather is wet and improper for their being driven and folded upon the ploughed

* Synopſis of Huſbandry.

lands *, as under ſuch circumſtances the lands are not only often much injured by the practice, but the animals greatly hurt.

The ſheep, in all caſes of folding for the improvement of arable lands, ſhould be ſuffered to fill themſelves very well on the paſtures or other grounds, before they are driven to, and incloſed in the folds on the ploughed lands. Hence it is probably the beſt method to let them remain on the green food the whole or the greater part of the day, and only incloſe them in the folds during the nights, as in this way the greateſt amelioration will not only be effected, but the leaſt injury ſuſtained by the animals. In the mornings before they are turned out of the folds, it may be a beneficial cuſtom to have them driven briſkly once or twice about the folds, in order to promote the evacuations of urine and dung. This may alſo, at the ſame time, be uſeful in promoting the circulation, and benefiting the health of the animals.

The kinds of ſheep that are the moſt ſuitable to be employed in this buſineſs, are thoſe of the Devonſhire, or weſt-country breed, as being the moſt hardy, and bearing the confinement of the fold better than thoſe of the larger and finer kinds; but many of the other ſorts may be made uſe of in the ſame way, in diſtricts where the above breeds are not kept, though a little more care may be required in the managing of them.

Warping.—This is a method of manuring and improving tillage lands, that can only be practiſed in particular ſituations, as in the vicinity of large rivers and waters into which the tides of the ſea flow, and where the level of the grounds is ſuch as readily to admit of their being overflowed by them. The aim of the agricultor in this mode of manuring land is, by admitting the floods or tides of ſuch rivers to flow over and ſtagnate upon the land, to obtain a conſiderable ſediment or depoſition of muddy and ſlimy or other matter upon the ſurface of the ground, ſo that a new ſoil may as it were be created. In order to this, the tide is let in at high water to depoſit the warp or enriching ſubſtance, and ſuffered to run off again as it falls. But to produce the full effect, it will be neceſſary to have the water under ſuch command that it may be kept out or let in as occaſion may demand. This is accompliſhed in moſt caſes by the cutting canals ſo as to join the rivers, and fixing ſluices at the heads of them, which may be regulated at pleaſure, ſo as to admit the water of the ſpring-tides only, and others in proper places for diſcharging or taking it off the land. And that the water may ſtagnate upon the lands to a ſufficient depth, and be prevented from overflowing the adjoining grounds,

* Anderſon's Eſſays, vol. III. p. 27.

banks are raiſed all round the incloſures to be warped, of from three to ſix or ſeven feet in height, according to the ſituation and other circumſtances of the land, having proper ſlopes on each ſide. Where the land to be improved by this means is of conſiderable extent, the main canal may be cut to a great length, ſo as to warp the lands on each ſide of it, by lateral cuts in ſuitable directions to a conſiderable diſtance. But as the effects in theſe caſes are found to diminiſh in proportion to the diſtance from the river, a greater length of time will be neceſſary for the depoſition of the warp according to the diſtance from it *. That it is not the water that produces the benefit in theſe caſes, but the depoſition of mud, is evident from the buſineſs being diſcontinued in the warping diſtricts during freſh-water floods, as well as in the winter ſeaſon. The reſult of the analyſis of this muddy ſediment, has ſhewn it to conſiſt of much mucilage, a very ſmall portion of ſaline matter, with a large one of calcareous earth; the reſidue being mica and ſand, each in a very minute ſtate of diviſion, and the latter in much the largeſt proportion. It is alſo ſuggeſted, that though no mention is made of any argillaceous material, from examination of the warp on the fields, it is obvious, that it is preſent in ſome caſes. The ſtiffer ſorts of warp are alſo ſuppoſed by ſome to be the beſt †.

* The following directions for managing this buſineſs are given by Lord Hawke, in the Agricultural Survey of the Weſt Riding of Yorkſhire:

"The land to be warped muſt be banked round againſt the river. The banks are made of the earth taken on the ſpot from the land: they muſt ſlope ſix feet; that is, three feet on each ſide of their top or crown of the bank, for every foot perpendicular of riſe: their top or crown is broader or narrower, according to the impetuoſity of the tide, and the weight and quantity of water; and it extends from two feet to twelve: their height is regulated by the height to which the ſpring tides flow, ſo as to exclude or let them in at pleaſure. In theſe banks, there are more or fewer openings, according to the ſize of the ground to be warped, and to the choice of the occupier, but in general they have only two ſluices, one called the flood-gate to admit, the other called the *clough* to let off, the water gently; theſe are enough for ten or fifteen acres: when the ſpring-tide begins to ebb, the flood-gate is opened to admit the tide, the clough having been previouſly ſhut by the weight of water brought up the river by the flow of the tide. As the tide ebbs down the river, the weight or preſſure of water being taken from the outſide of the clough next the river, the tide water that has been previouſly admitted by the flood-gate opens the clough again, and diſcharges itſelf ſlowly but completely through it. The cloughs are walled on each ſide, and ſo conſtructed as to let the water run off, between the ebb of the tide admitted, and the flow of the next; and to this point particular attention is paid. The flood gates are placed ſo high as only to let in the ſpring-tides when opened. They are placed above the level of the common tides.

"Willows are alſo occaſionally planted on the front of the banks to break the force of the tides, and defend the banks by raiſing the front of them with warp thus collected and accumulated: but theſe willows muſt never be planted on the banks, as they would deſtroy the banks by giving the winds power to ſhake them."

† Young's Survey of the County of Lincoln, p. 277.

As a ſort of new ſoil is created by this practice, it is of but little conſequence what the nature of the land may be, almoſt all kinds being improved by it. It will probably, however, be the moſt beneficial in ſuch light ſoils as are very open and porous, and ſuch ſtiff ones as are defective in calcareous matter, and which require ſubſtances of this kind to render them leſs tenacious. The beſt ſituation of land for performing this buſineſs in, is when it is in the ſtate of fallow; but it may be done when in that of ſtubble, or other ſimilar condition, and even in that of ſward, when the graſs begins to decline. The ſeaſon of doing it is generally in the ſummer months, from May or June till Auguſt, or September, as at theſe times the lands not only become the ſooneſt dry, a circumſtance which muſt always fully take place before the proceſs of cultivation can be carried on, but the tides are leſs mixed with freſh water, in which ſituation they are conſtantly found the moſt effectual. Land, when once well warped, will continue for a great length of time in good condition; but notwithſtanding this, it is ſuggeſted by ſome perſons converſant with the buſineſs, as a better practice to apply a ſmall portion of warp whenever the land is in the ſtate of fallow, which, under the arable ſyſtem, will be about every five or ſix years. By this means the farmer will be more ſecure of having good crops. The depth to which the lands are covered with the water muſt be various according to the differences of their levels, and the heights of the tides in the rivers from which they proceed. When it can be done, it may be admitted to the height of three or four feet or more, as the depoſit of ſediment is in ſome meaſure proportionate to the height of the water, though the ſame effects may be obtained from much ſmaller quantities of water, by continuing the proceſs a greater number of tides. Lands that have been ſubjected to this mode of improvement ſhould conſtantly be kept in the ſtate of tillage for ſome length of time afterwards, in order that it may be brought to a proper condition for the production of graſs †.

The expence of this method of improving lands will be very different in different caſes, as the circumſtances of ſituation and diſtance vary; but it can ſeldom exceed twelve or fifteen pounds the acre ‡, and in moſt inſtances it muſt be greatly below ſuch eſtimates, probably not more than a third of them ‖.

† Brown's Agricultural Report of the Weſt Riding of Yorkſhire.

‡ Young's Survey of the County of Lincoln, p. 284.

‖ It is remarked by Mr. Day, in the Agricultural Survey of the Weſt Riding of Yorkſhire, that no eſtimate can be made without viewing the ſituation of the lands to be warped, and the courſe and

Lands after having undergone this proceſs are moſtly capable of producing abundant crops of almoſt any kind; but in general oats are the moſt to be depended upon for the firſt ſeaſon; and they are ſaid to be more proper for the growth of this ſort of crop, and thoſe of wheat and beans, than barley, as the ſoil becomes ſo rich in this way, that it ſuffers in general by being too rank and coarſe. Flax may likewiſe be grown in many caſes to great advantage. They are alſo admirably adapted for potatoes, as well as various kinds of ſeed crops, and the being laid down for the purpoſe of paſture *.

The practice of warping is adopted on the rivers Trent, Ouſe, and Dun, with great benefit; and upon the low lands that are ſituated near to large rivers, in other parts of the kingdom, the tide waters of which are often muddy, it may probably be had recourſe to with equal ſucceſs.

Sowing.—In order to perform this buſineſs in the moſt advantageous and perfect manner, it will be neceſſary for the agricultor to pay particular attention to a variety of different circumſtances, ſuch as the quality, preparation, and quantity of ſeed that is to be put into the ground, the time and depth of ſowing it, the ſtate of the ſeaſon, and climate in which it is to be ſown; the nature of the land, and the particular kind of ſeeds or plants that are to be cultivated upon it, for on properly regulating and adapting his practice to theſe points,

diſtance it will be neceſſary to carry the warp to ſuch lands, as, 1ſt. The ſituation of the lands muſt be conſidered. 2dly. The quantity of land the ſame drains and cloughs will be ſufficient to warp. 3dly. The expence of building the cloughs, cutting the drains, embanking the lands, &c. An eſtimate of which expence being made, then it will be neceſſary to know the number of acres ſuch cloughs and drains will warp, before any eſtimate per acre can be made; therefore it will be eaſy to conceive the greater quantity of land, the ſame cloughs and drains will warp, the eaſier the expence will be per acre. In his opinion there are great quantities of land in the country, which might be warped at ſo ſmall an expence, as from £.4 to £.8 per acre, which is nothing in compariſon to the advantages which ariſe from it. He has known land which has been raiſed in value by warping, from £.5 to upwards of £.40 and £.50 per acre; therefore it is eaſy to conceive that the greateſt advantages ariſe upon the worſt land, and the more porous the ſoil the better, as the wet filters through, and it ſooner becomes fit for uſe. The advantages of warping are very great; as, after lands have been properly warped, they are ſo enriched thereby, that they will bring very large crops for ſeveral years afterwards, without any manure; and, when it is neceſſary, the lands might be warped again, by opening the old drains, which would be done at a very trifling expence, and would bring crops in ſucceſſion for many years, with very little or no tillage at all, if the lands were kept free from quick graſs, and other weeds, which muſt be the caſe in all lands where they are properly managed; beſides the drains which are made for the purpoſe of warping, are the beſt drains that can be conſtructed for draining the lands at the time they are not uſed for warping, which is another very great advantage in low lands.

* Agricultural Survey of the Weſt Riding of Yorkſhire.

much of his ſucceſs will probably depend. It will alſo be of much utility to have regard to the particular modes in which the ſeeds or plants are to be put into the ſoil, as ſome variation will be required according as they are ſown or put in by the broadcaſt, drill, or dibbling methods.

It ſeems to be ſhewn by the experiments and obſervations of an intelligent philoſophical enquirer, that grain or ſeed during the act of vegetation draws oxygen from the atmoſphere, part of which is retained, and the remainder thrown off charged with a portion of carbon. In this proceſs the ſubſtances of the ſeed-lobes, therefore, undergo a conſiderable change, an additional proportion of oxygen entering into their compoſition, while a portion of their carbon is diſſipated. By this alteration in the proportion of their conſtituent principles, the ſaccharine fermentation takes place, and ſugar is formed, as demonſtrated in the operation of malting grain. The ſugar and carbonic acid, from their being more ſoluble in water than the *oxyd* of the farinaceous matter, eaſily, it is ſuppoſed, combine with the moiſture in the capillary veſſels of the ſeed, and find a ready paſſage to the germ, the vegetative principle of which is thus brought into action by a *ſtimulus* adapted to the particular nature of it. By the decompoſition of the ſeed-lobes, a nutritious fluid being thus formed and diſtributed through the infant plant, its organs are excited to exert their ſpecific actions, in decompounding the nouriſhment conveyed to them, and in forming new *oxyds* from the elementary principles of it, in order to the increaſe and evolution of the veſſels and fibres*. In this way, it is imagined, the firſt ſtage of vegetation commences; which, if the ingenious author's concluſions be well founded, would ſeem to ſhew that the grain or ſeed, in order to its undergoing theſe different changes the moſt readily, and in the moſt perfect manner, on which, perhaps, healthy vegetation may depend, ſhould not only be properly depoſited in the ſoil, but be ſo well ripened and filled with farinaceous matter, and poſſeſs ſuch a degree of moiſture, as may diſpoſe it to undergo ſuch changes in a ſpeedy manner, while at the ſame time a due ſupply of ſuitable nutritious matter is afforded for the healthy germination, and early growth of the young plant.

In reſpect to the choice of ſeed of the grain kinds, as frequently as poſſible, it ſhould, therefore, be a rule with the farmer to purchaſe or reſerve ſuch as is the moſt full, plump, ſound, and healthy, of whatever deſcription it may be, as it is only in this way probably that crops of good grain can be inſured. And this practice is further enforced from the circumſtance of its being in ſome

* Gough on the Vegetation of Seeds, in the Memoirs of the Mancheſter Society, vol. IV. p. 310.

meaſure the ſame with plants as with animals, that the produce is in a degree ſimilar to that from which it originated.

But it is not merely on this principle that ſuch grain as is ſmall, ſhrivelled up, and imperfectly fed, ſhould be rejected as improper for ſeed; but as containing a ſmaller proportion of farinaceous matter, and being thereby, as has been ſeen, leſs proper for affording that degree of nouriſhment and ſupport which is neceſſary to the young plants during the period of germination, or the firſt ſtage of their growth. Where ſuch ſeed as is ſhrivelled up, and imperfectly ripened, is ſown, in general but a little of it vegetates, and that which does, moſtly ſends forth plants of a weak and feeble kind, that afford only a lean and ſteely ſort of grain. Beſides theſe, there are other circumſtances which ought to be taken into the account in the choice of ſeed corn, ſuch as that it be new and recently threſhed from the ſtraw, and that the ſkin be clear and thin; for it is found that grain which is freſh and only juſt threſhed out, is in a much more proper ſtate for quick vegetation than ſuch as has been long kept, conſequently leſs liable to periſh in bad ſeaſons; and that where the rind or ſkin is of a bright colour, and thin, a much larger proportion of fine farinaceous or mealy matter is yielded from the ſame quantity of grain, which renders it of courſe more valuable to the cultivator. This is particularly the caſe in wheat, and the ſame thing probably takes place in reſpect to other ſorts of grain. The experiments of a late writer ſeem indeed to ſhew, that wheat, after being kept ſix or ſeven years, though there may not be any perceptible difference in its appearance from ſuch as is new, is wholly unfit for being made uſe of as ſeed, on account of only a ſmall portion of it being capable of vegetating*. This may, probably, in many caſes be owing to the grain being more diſpoſed under ſuch circumſtances to take on the putrefactive fermentation, or become rotten, than to the abſorption of oxygen, which is believed to be eſſential to the proceſs of vegetation, in the early ſtage†. It is probable, too, that beſides this effect where the moiſture and juice of the grain is much taken away, as is the caſe in keeping it for a conſiderable length of time, the plants that are produced from it may even be leſs vigorous and luxuriant, as happens in gardening to ſome kinds of ſeed, as that of the mellon, which is frequently kept for ſeveral years, in order to effect this purpoſe the more fully.

On the principles which have been ſtated above, it is therefore obvious, that in

* Synopſis of Huſbandry, p. 80.

† Gough on the Vegetation of Seeds in Mancheſter Tranſactions, vol IV. p. 310 & 488.

order to ſecure the moſt perfect vegetation of grain, it ſhould not be placed too much out of the influence of the atmoſpheric air, and that the bed of earth in which it is depoſited be in as fine a ſtate of pulveriſation as poſſible, as under ſuch circumſtances the air is more uniformly admitted, and the ſeed, from being in a more equal temperature, and more equably ſupplied with moiſture, is expoſed in the moſt favourable manner to the combined effects of the cauſes that have been found to promote the germination, growth, and proſperity of the young plant *.

As to ſuch grain as is in any way diſeaſed, it ſhould never be made uſe of as ſeed. The experiments of the author of the Synopſis of Huſbandry clearly prove, that no method of preparation that has been yet attempted has been ſufficient to render it capable of producing healthy plants. In his different trials he invariably found, that in wheat which was affected with the *ſmut*, the grains univerſally produced a ſucceſſion of ears that were tinged in a greater or leſs degree with the diſtemper, and that neither ſteeping nor the change of ſoil made any difference in preventing it, but that that which had been ſteeped and limed, as well as that which was ſown dry, afforded diſeaſed ears. The ſowing of this ſort of ſeed, though it may have been adviſed by ſome incautious agriculturs who have placed too much confidence on the efficacy of *ſteeps*, can only diſappoint the expectations of the farmer in propagating more widely the ravages of ſuch vegetable diſeaſes, and producing ſcanty ſupplies of ſound grain.

There is ſtill another point that ought not to be overlooked in regard to ſeed corn, which is that it be clean and perfectly free from the ſeeds of every ſort of weed, as where this is not ſufficiently attended to, crops may be greatly injured, if not wholly ſpoiled, by the growth of weeds, and ſuch noxious plants introduced into the ſoil as cannot be removed again without conſiderable trouble and expence.

There are different methods that may be purſued in order to ſecure ſuch grain as is healthy, and proper for the purpoſe of ſeed. The beſt is probably that of ſelecting from amongſt the corn while it is growing in the fields, as in this way an opportunity is afforded of chooſing ſuch heads or ears of the plants of different kinds, as are the moſt perfect, the moſt forward and vigorous in their growth, and which contain ſeed that is the moſt plump and full, and the beſt ripened. Theſe advantages may likewiſe, in ſome reſpects, be attained in the more valuable ſorts of grain, by having them picked over by the hand after

* Gough on the Vegetation of Seeds, in the Manchester Tranſactions, p. 324.

being threſhed out; but the practice is tedious, and not ſo certain of having the ſeed from the moſt healthy and beſt ripened plants.

In order to be poſſeſſed of the beſt and moſt perfect ſorts of ſeed, the moſt healthy and vigorous plants ſhould therefore be choſen, and ſuch as are the moſt early in reſpect to the ſeaſon, and theſe while growing be ſo preſerved that they may not be injured by having weaker plants of the ſame kinds near them; as the art of having good ſeeds does not, it is aſſerted by an experienced agricultor, depend upon obtaining new ſeeds from ſituations at a conſiderable diſtance; but upon collecting and preſerving the beſt ſeeds or roots of our own production. This method of practice has been adopted in conſequence of having remarked that, though vegetables of every kind are extremely liable to undergo changes in regard to the periods of their becoming ripe and other properties, the beſt ſeeds never fail to afford the beſt plants *.

In preſerving ſeed grain, by collecting it in the ears from the ſtack, there may however, it is obſerved, be diſadvantages, both in the way of leſſening the produce by chooſing the largeſt ears which have ſeldom more than one upon a ſtem, and by taking ſuch as become ripe at different periods †.

There are various methods of aſcertaining the goodneſs of grain or ſeeds, but the farmer chiefly depends upon the appearances that they exhibit, preferring ſuch as are full, plump, well fed, and that have a certain brightneſs and clearneſs, without any ſhriveling or ſhrinking in the covering or ſkin.

The ſame purpoſe may, however, be accompliſhed with greater accuracy by other means, as the weighing of a certain meaſure; it being well known that grain or ſeeds, on being immerſed in fluids, have the more light and imperfect floating on the ſurface, while the better and more perfect ſink to the bottom. On this principle, ſolutions well ſaturated with ſaline ſubſtances, from their gravity being much increaſed, become excellent for aſcertaining the goodneſs of grains; as none but ſuch as are perfectly ſound will ſink in them.

It is obſerved by the author of Phytologia, that the weight of a given meaſure of grain may alſo be a tolerably certain method of diſcovering the quantity of huſk or bran contained in it, compared to the quantity of flour; as that grain which is cut too early, or which is otherwiſe not quite ripe, as happens in wet ſeaſons, ſhrinks in the barn or granary, and becomes wrinkled, and has thus a greater proportion of ſkin or bran than that which has been more perfectly ripened, and will hence weigh lighter in proportion.

* Prieſtley in Communications to the Board of Agriculture, vol. I. † Ibid.

Another method that may be had recourſe to in order to diſtinguiſh light from heavy grain, is that of winnowing, as the ſurfaces of light grains, from their being greater in proportion to their ſolid contents, will be carried further by the current of air afforded in the operation; yet in paſſing them through a ſcreen the heavy grains may be liable to run further out on the floor from their being more propelled by their greater gravity, without the reſiſtance of the air on their ſurfaces being increaſed *.

And as grain that has undergone fermentation, or been heated much, or burnt in the ſtack, as it is moſtly termed by farmers, is improper for ſeed, from its not being capable of vegetating, it may be of utility in many caſes to be able to diſcover where this has happened. The following method, which is perfectly ſimple, has been recommended for the purpoſe. A paſte is to be made with water from the flour of the ſuſpected grain, which is then to be waſhed by the hand under water, which is frequently changed, until no diſcolouration of it takes place. The ſubſtance which is left in the hand is the glutinous part of the grain, and which, if the corn be good, is elaſtic, contracting readily on being drawn out; if it has only been juſt heated, it is brittle; but where it has fermented, none of the gluten will be afforded †.

Much has been advanced by ſome agricultors on the importance of changing of ſeed of the ſame kind, probably from adopting imperfect notions of the nature of vegetation, or purſuing falſe analogies in reſpect to the breeding of animals, but it is evident from the trials that have been made in the cultivation of grain, and from what happens in particular caſes of gardening, that it will be of no utility to have recourſe to the change of ſeed, provided it is properly adapted to the ſoil, except it be for an improved kind. The only thing neceſſary is that of collecting and preſerving the beſt of the different kinds, in the methods that have been directed above, and by that means prevent a degeneracy. It is hardly to be ſuppoſed that the ſoil can become tired of, or be improper for, producing a ſort of grain for which it is adapted, ſince it may be obſerved that the ſame ſorts of plants are frequently propagated on the ſame ſpots of ground for a vaſt length of time without any manifeſt injury in reſpect to their quality.

As ſome of the varieties of the ſame ſort of grain or ſeed, when ſown under ſimilar circumſtances of ſoil and climate, are however often found by the cultivators of land to be of a much more early growth than others, as well as of

* Darwin's Phytologia, p. 455. † Mon. B. G. Sage, in Journal de Phyſique, 1794.

a more or leſs hardy and vigorous nature, it may be of utility to change them in theſe reſpects, the early kinds being always cultivated on the colder and more backward deſcriptions of land, while thoſe of the later are ſown upon the drier and more warm ſoils. In this way the crops may often be conſiderably improved, as, in ſo far as regards themſelves, they will enjoy the advantages of more genial ſoils and climates. Another advantage may be gained in this method, as by employing ſuch early kinds of ſeed the farmer may, in ſome caſes, delay the putting in of his ſeed for ſeveral days, without the danger of the crop being injured thereby, or of its not being reaped at the uſual time. He may likewiſe in the late ſoils thus obviate the difficulties and inconveniences attending bad ſeed times, as by ſuch a change the ſeed, though put in later, may be equally early at the harveſt *.

It has alſo been remarked, that there is an advantage reſulting from changing ſeed from ſoils of oppoſite natures, which cannot be depended upon when the change is made from ſimilar ſoils. Some weeds will grow only in ſtrong deep lands, while others are peculiar to light and ſandy ſoils. When, from whatever cauſe, grain abounds ſo much with the ſeeds of weeds as to render it improper for ſowing, by procuring ſeed from a ſoil of an oppoſite nature the farmer is to a great degree certain that no dangerous ſeed-weeds will be introduced by the change †. The ſowing of ſuch grain as contains the ſeeds of weeds ſhould, however, never be practiſed, except where perfectly clean ſeed cannot be procured, as, though the above may be the caſe in regard to particular ſorts of weeds, it does not by any means extend to all.

It is found that grain, like all other ſeeds and plants, when brought from a warmer to a colder climate, gradually degenerates till, by being frequently cultivated, it becomes natural both to the ſoil and climate. And experience has ſhewn that it degenerates ſooner, and to a greater degree, in mountainous diſtricts, than in the level and better ſheltered parts of the country. At the ſame time, it is well known, that many vegetables introduced from other countries, and which it was once thought would not come to maturity in this, have, by proper care and attention, been brought to a great degree of perfection. It is certain, too, that the introduction of better ſorts of grain has ſoon become effectual in removing the poor kinds that were originally cultivated. This has been the caſe in reſpect to oats in ſome parts of Scotland: which is a circumſtance that, the writer juſt mentioned thinks, proves how much the quality of

* Donaldſon's Modern Agriculture, vol. II. p. 261. † Ibid.

grain may be improved by proper attention; and further, that frequent and judicious changes of ſeed, in the way ſtated above, are of the greateſt importance in effecting this improvement.

And it is concluded, that from the long-eſtabliſhed practice, and the acknowledged advantages derived from annually importing ſeed-wheat from England into all the diſtricts in Scotland, where that ſpecies of grain is cultivated, which are well known; as well as from the practice being no leſs general, although more local, for the farmers in Banff-ſhire, where deep ſtrong cold ſoils prevail, to procure, in unfavourable ſeaſons, a great portion of the oats neceſſary for ſeed from the light dry ſandy ſoils in the adjoining county of Moray; and alſo the practice of many other diſtricts where improved agriculture is to any conſiderable degree eſtabliſhed; it will be found that frequent changes of ſeed, for ſome or other of the reaſons mentioned above, are not only highly proper but indiſpenſably neceſſary *.

On the whole it is maintained by an ingenious writer, that as the varieties of plants are ſuppoſed to be produced by different ſoils and climates, which varieties will afterwards continue through many generations, even when the plants are removed to other ſoils and climates, it muſt be advantageous for the agricultor to inſpect other crops, as well as his own; and thus wherever he can find a ſuperior vegetation, to collect ſeeds from it; which is, it is imagined, more certain to improve his crops than an indiſcriminate change of ſeed. And that where ſeed-corn is purchaſed without a previous obſervation of its ſuperior excellence, perhaps it would be more advantageous to take it from better kinds of ſoil, and from ſomewhat better climates; as the good habits acquired by ſuch ſeeds may be continued long after their removal to inferior ſituations. But, on the contrary, care ſhould be taken not to collect a change of ſeeds from worſe climates or inferior ſoils, unleſs the agricultor is previouſly certain that they are of a ſuperior kind †.

Though the practice of preparing ſeed of particular kinds for being put into the earth, by ſome means or other, ſeems to have prevailed, in ſome degree, ſince the earlieſt periods of the art of huſbandry, the utility or advantage of the proceſs does not appear to be yet fully aſcertained by agricultors; ſome contending that it is highly beneficial, while others maintain that no poſſible benefit can be derived from it. It can, however, hardly be conceived, that a practice of this ſort ſhould have been employed for ſuch a vaſt length of time, without ſome

* Donaldſon's Modern Agriculture, vol. II. p. 263. † Darwin's Phytologia, p. 452.

beneficial conſequences had been obſerved to reſult from it. The nature of the vegetation of ſeeds, and the circumſtances under which it takes place in the moſt favourable manner, would alſo ſeem to ſhew that it may be had recourſe to with benefit in more caſes than it appears to have been cuſtomary to employ it by the farmer.

Various compoſitions have been employed at different times for the purpoſe of preparing grain which is to be made uſe of as ſeed. In the more early attempts in this way, oils, and the decoctions or juices of particular plants, were chiefly employed, and the moſt fully relied upon; but the liquors which have lately been the moſt depended upon, are either water ſo highly impregnated with common ſalt that an egg will ſwim upon the ſurface of it, or ſuch chamber-lye as has been kept for a length of time ſufficient for its undergoing decompoſition, and the forming of ammonia. And whichever of theſe liquids is made uſe of, the ſeed, after being ſteeped for a proper length of time, is rendered dry and fit for ſowing, by cauſtic or quick lime, in a fine ſtate of pulveriſation, being intimately blended with it.

By modern agricultors, ſteeps or pickles of theſe kinds appear to have been principally made uſe of for preparing wheat, in order to prevent it from being affected with diſeaſe; but it is probable that they may be applied to moſt other kinds of ſeed, and in very different views, with ſtill greater and more beneficial effects. As it would ſeem neceſſary that the ſeed-lobes of grain, which have been found to conſiſt of a vegetable *oxyd* or baſis, compounded of carbon and hydrogen, impregnated with oxygen, a portion of oil, or of the baſis of it in an unoxydated ſtate being diffuſed through their compoſition *, ſhould be imbued with a certain proportion of humidity or moiſture, in order that ſuch changes may take place in them as are ſuited to the proceſs of vegetation; the ſteeping of ſeed may, in this way, not only ſecure a more ſpeedy and regular germination, but in ſome caſes obviate the danger of its being injured or deſtroyed by the length of time it may be neceſſary for it to remain in the ſoil before it becomes ſufficiently moiſtened. And as it is probable that different kinds of ſeed abſorb or take up different proportions of moiſture in the ſame time, this circumſtance ſhould be attended to in the practice, and ſuch ſorts as are found to charge themſelves ſlowly, expoſed in the ſteeps for a greater length of time †.

In proof of the utility of ſteeping in this view, it has indeed been obſerved,

* Gough, in Memoirs of the Manchester Society. † Ibid.

by an experienced agricultor, that there can be no doubt that, in every particularly dry ſeed time, ſeed of every kind ought to be ſteeped juſt enough to promote a quick vegetation. This method would, it is thought, at all times prevent great deſtruction by vermin, ſecure a more uniform growth, and greatly improve both the quantity and quality of barley and oats; and ſometimes, indeed, procure a crop of clover, which would, without ſuch precaution, have been loſt *. And others ſuggeſt that by ſoaking ſeeds a day or two previous to their being put into the ſoil, their growth may be promoted equally as well as by watering the land by artificial means, either immediately before or after their being ſown †. But beſides theſe, the ſteeping of ſeed-grain may be uſeful in other reſpects; as, where attention is paid to having the liquors as much as poſſible ſaturated with ſaline matters, it may, as has been ſeen, enable the farmer to readily ſeparate the faulty imperfect ſeed that is incapable of vegetating, from that which is good and proper for the purpoſe, as the light imperfect ſeeds conſtantly float upon the ſurface of ſuch liquids, and may be eaſily removed, while thoſe which are ſound and good fall to the bottom, and by being employed as ſeed may inſure more regular, perfect, and uniform crops.

And where liquids or ſubſtances of a poiſonous or deſtructive quality, ſuch as the ſolutions of noxious plants, cauſtic lime, &c. are had recourſe to, they may be of utility both by rendering it leſs the prey of vermin, and deſtroying ſuch as attack it. The latter may likewiſe be of advantage by its properties of attracting the humidity and moiſture of the ſurrounding air and ſoil, as well as by deſtroying ſuch inſects as come in contact with it ‡.

It may, in ſome inſtances, alſo be of advantage to make uſe of ſuch liquid materials as have been found uſeful in promoting the growth of plants, ſuch as the carbonated liquor afforded by dung-hills, and many ſimilar matters. It has been found, that by ſteeping ſeed-barley for twenty-four hours in a fluid of this ſort, removing the light grains that came to the top, and, on taking the grain out of the ſteep, ſifting wood aſhes over it in order that it might be ſown with regularity, a much better crop was produced than from the ſame grain ſown without undergoing any preparation ‖. In China, the uſe of ſuch fluids for the ſteeping of ſeed is likewiſe ſuppoſed to be equally beneficial in promoting the growth of the crop, and preventing it from being deſtroyed by inſects §.

Others, however, aſſert that ſolutions made with various ſubſtances, which

* Middleton's Survey of Middleſex, p. 141. † Darwin's Phytologia, p. 464. ‡ Ibid.

‖ Chappel, in Memoirs of Bath Society. § Staunton's Embaſſy to China.

are ſuppoſed to have a tendency to promote the vegetation of ſeeds, have been employed without their producing any beneficial effects *. But as little ſeems to have been done in the way of experiment with a view to aſcertain this point, and as it is well known that both moiſture and the recrements of vegetable and animal matters are highly uſeful in aiding the growth of the plants in their more advanced ſtages, it may be concluded that they may have advantageous effects when applied to, and taken up by, the ſeed in the liquid ſtate, though it is obvious that their power in this way muſt be conſiderably limited, not only from the ſmallneſs of the quantity imbibed, but from the ſeed containing the proper materials of its early nouriſhment within itſelf.

In regard to the effects of ſuch preparations in the prevention or removal of the diſeaſed conditions of ſeed, there are different opinions entertained by agriculturs; ſome contending that they are wholly ineffectual, while others maintain that they have derived the moſt evident advantages from them. Satisfactory experiments have, however, yet gone but a little way in determining the matter. The few trials that have been made by the author of the Synopſis of Huſbandry, with reſpect to ſmutty grain, ſeem to ſhew that they cannot be much depended upon in this view, though they do not throw much light on the nature of the diſeaſe. A writer of much experience and acuteneſs of obſervation is, notwithſtanding, decided in his opinion of their utility, having wholly prevented the diſeaſe by making uſe of them †. In his attempts he appears, however, to reſt much of the effect upon the lime employed being newly burned and ſlaked in boiling water, and the ſteep or mixture being then poured *boiling-hot* over the grain previouſly ſpread out on a ſtone floor, afterwards blending it well by frequent turning. The heat of the water, ſays he, aided by the ſuffocating ſmell of the fixed air diſcharged from the lime, ſeems to be ſufficient to deſtroy the animalculæ to which ſome aſcribe the ſmut, and alſo to coat the wheat ſo as to become a preſervative from vermin. And the able author of the Agricultural Survey of Staffordſhire aſſures us, that the propriety of the practice, and its good effects in the preventing of the ſmut, are eſtabliſhed by the moſt weighty of all arguments, experimental proof; and further that he has never known or heard of a well-authenticated inſtance of its failure in preventing the diſeaſe. Experiment has not, however, fully demonſtrated that this vegetable diſeaſe proceeds from animalculæ, or that carbonic acid gas is effectual in deſtroying them. It is more probable that the heat thrown out dur-

* New Farmer's Calendar, p. 417. † Middleton's Survey of the County of Middleſex.

ing the combination of the water with the lime, together with the cauſtic properties of the latter might produce ſuch effects. However this may be, the utility of the practice is rendered ſtill more probable by the author of Modern Agriculture giving it as the reſult of the experience of agricultors in general, that where it is followed ſmut is ſeldom or never ſeen in the ſucceeding crop *.

When ſteeps of this nature are, however, employed in this view, it would ſeem that the ſeed ſhould lie much longer in them than when the intention is merely that of ſeparating the imperfect from the good and ſound ſeed †.

The manner of performing the buſineſs of ſteeping is different in different places; but the moſt common way is that of forming the brine, in the mode that has been mentioned, in a large tub or other convenient veſſel, and then ſimply putting in the grain and permitting it to remain for ten or fifteen hours, removing the light grains as they come to the ſurface, after ſtirring it at different intervals. But another, and much more expeditious and convenient method, is that of placing the ſeed in a baſket, and letting it down into the veſſel containing the ſteep, ſkimming off the light corn occaſionally, and after it has remained a proper length of time, according to the views of the agricultor, removing its contents, and replacing them by other parcels.

In whichever way the proceſs of the ſteeping is performed, no larger a quantity is to be prepared at a time than is capable of being put into the ground the ſucceeding day, as where the grain is ſuffered to remain in the ſteep for any great length of time, much of it is found to be incapable of vegetating ‡. In further proof of this, the writer of the Agricultural Survey of Mid-Lothian ſays, that about four years ago, having ſteeped a firlot of barley in urine for about three hours, and immediately thereafter cauſed it to be ſown at the uſual rate, in the middle of a field, unmixed with any other, there was not above a half of it came up, and even that grew ſo weakly as not to produce above a third part of the crop with the reſt of the field. An able experimenter has, however, ſhewn that greater latitude may be taken in this reſpect than is commonly ſuppoſed ‖. And Mr. Middleton has known ſeed prepared a week before it was ſown, without ſuſtaining any injury. As the experiments of Mr. Gough have, notwithſtanding, ſhewn that the proceſs of germination preſently commences after ſeeds have been

* Vol. II. p. 281. † Curſory Obſervations on Huſbandry, p. 63.

‡ Donaldſon's Preſent State of Huſbandry, p. 281. ‖ Gough, in Memoirs of Mancheſter Society.

imbued with a ſuitable proportion of humidity, it would ſeem to be the moſt proper practice not to delay the ſowing much after the ſeed has been prepared.

In regulating the proportion of ſeed that may be neceſſary to be ſown, attention will not only be requiſite to the peculiar nature, quality, and ſituation of the ſoil, and the periods of ſowing or putting crops into the ground, but alſo to the ſtate of the ſeaſon, and the manner in which the ſowing is performed.

In general, for moſt ſorts of crops, the ſtrong, wet, and ſtiffer deſcriptions of land will require larger proportions of ſeed than ſuch as are more friable, thin, and light. Hence the ſtrong wet loams, and the ſtiff retentive clays, demand more ſeed than the light mellow loams, and the ſandy, gravelly, or even the thin chalky ſoils. As where lands of the rich loamy kinds have been ſuitably broken down, and reduced by the various operations of tillage already deſcribed, if the ſeed be not ſown in too large a proportion, an opportunity is afforded for the plants tillering, or ſpreading themſelves from the roots, many ſtems often iſſuing from the ſame root: in conſequence of which, the crops frequently become, even when thinly ſown, extremely thick upon the ground; and from the great nutritive powers of ſuch ſoils, or what is moſtly termed ſtrength by farmers, would be greatly too much ſo, if a large proportion of ſeed were at firſt put in.

And, indeed, in the caſe of root crops, whether ſuch as are formed upon or within the ſoil where ſuch lands are in a ſufficiently mellow and friable ſtate for producing them, the ſeeds or ſets ſhould not on the ſame account be ſown or put in in too great a quantity or too thickly.

But in the ſtrong, ſtiff, wet, retentive, ſoils, from the plants ſeldom ſtriking or branching off much from the roots, except in particularly favourable circumſtances of ſeaſon, a much greater proportion of ſeed will be neceſſary, in order to ſecure ſuch full crops as lands of this kind are capable of ſupporting.

On the light thin ſoils a leſs quantity will be ſufficient, as if a large proportion of ſeed be put into ſuch kinds of ground, from their poſſeſſing but little ſtrength in compariſon with the former, the crops will rarely, except in particular ſeaſons, be well formed in the ear, or have the grain plump and well fed *. It is likewiſe a practice in the beſt grain diſtricts, on all deſcriptions of ſoils, to ſow ſmaller proportions of ſeed on lands of the ſame quality in the early periods of the ſeed time, than thoſe of the later. The reaſon of this, ac-

* Donaldſon's Preſent State of Huſbandry, p. 265.

cording to the author of the work juſt quoted, is, that grain ſown early in the ſeaſon takes deeper root, and has more time to branch out additional ſhoots, than that which is late ſown, which, when the ſoil is not very free, as well as fertile, generally runs up into one ſingle ſtalk, ſo that if a liberal quantity of ſeed be not allowed, the crop, however luxuriant in reſpect to the plants, muſt be ſcanty in the article of grain.

There may alſo be other reaſons; as where the ſeed is put in at a late period, eſpecially in the ſpring ſowings, it will not have time fully to eſtabliſh itſelf in the ſoil before it becomes retarded by the hot and dry ſummer weather, unleſs a large quantity of ſeed be employed ſo as to afford protection by the cloſeneſs of the growth of the plants. And in the late autumnal ſowings, the grain may not become well fixed and rooted in the ſoil before the froſts begin to affect them, and on that account a larger proportion of ſeed be required.

The ſtate of the weather may likewiſe have conſiderable influence in reſpect to the ſowing or putting ſeed into the ground, as where the ſeaſon is very dry, and there is but a ſmall proportion of moiſture in the ſoil, more of the ſeed may fail in vegetating than where the contrary is the caſe. Hence the propriety of the practice of ſteeping and putting in the ſeed in ſuch dry ſeaſon immediately after the plough.

The manner in which the ſeed is depoſited in the earth muſt alſo produce conſiderable difference in regard to the quantity of ſeed, as where the grain is ſcattered over the whole of the land in ſome meaſure at random, as happens in the common broadcaſt method of ſowing, a much larger proportion of ſeed muſt be required, even with the moſt expert ſeedſman, than where the grains are depoſited with equality and exactneſs but only on certain portions of the land, as is the caſe in the drill and dibbling methods. Beſides, ſome diſadvantages may attend the firſt method in reſpect to the vegetation of the ſeed, that may likewiſe render a larger proportion requiſite.

From what has been advanced it muſt be evident that the quantity of ſeed muſt vary according to a great variety of circumſtances, and that it is a matter of much difficulty to fix upon any proportion that may be ſuitable to every circumſtance and deſcription of ſoil. From two and a half to three and a half buſhels to the acre may, however, in general, be conſidered as the proportion that will be the moſt frequently requiſite, both for the ſpring and autumn ſowings. It has been ſuggeſted by an experienced cultivator, that for ſowing wheat broadcaſt about the latter end of September, two buſhels and a half is the moſt advantageous quantity on ſoils of a medium quality; and that for every

fortnight later a gallon of ſeed ſhould be added *. Nothing can, however, be ſaid with much exactneſs on the ſubject, ſince the advantage of different proportions have not yet been fully ſhewn †.

* Middleton's Survey of Middleſex.

† Mr. Arthur Young, in his able Survey of the County of Lincoln, has given a tabular view of the quantity of ſeed and produce, which may be uſeful in ſhewing the effects of different proportions of ſeed on different kinds of land.

Kinds of Soil.	Places.	Wheat.		Barley.		Oats.		Beans.	
		Seed buſh.	Crop qrs.	Seed buſh.	Crop qrs.	Seed buſh.	Crop qrs.	Seed buſh.	Crop qrs.
Rich new broken up common land.	Long Sutton -	—	5	—	—	—	10½		
	Deeping Fen -	—	—	—	—	—	9		
	Holland Fen -	2½	4	—	—	6	7		
	Mr. Cartwright -	—	4½	—	—	—	8	—	4½
Middling land.	Folkingham - -	3	3½	3	5	5	6	4	3½
	Belton - -	3	2½	4	4½	7	5		
	Ditto Heath -	—	—	—	3	—	4		
	Leadenham - -	3	—	4½	4				
	Hackthorne - -	3	3	4	3½	5	4		
	Norton - -	3	2¾	3	4				
	Knaith - -	2½	3	4	5				
New incloſed land.	Haxey - -	2¼	3	4	4	4	5	3½	4
	Butterwick -	—	5	—	—	—	—	—	4
	Normanby - -	2½	3	4	4	—	—	4	3
	Winterton - -	—	4						
New incloſed land.	Barton - -	3½	4	4	4½	—	—	3	4½
	Mr. Graburn - -	4	—	—	—	7	—	4	5
	Mr. Scrivenor -	—	—	—	—	—	10		
	Barrow - - -	3	3						
Wold land.	Wintringham -	3	5	4	6	—	7	—	5
	Brockleſby - -	3¾	2½	4	4	7	5	3	3
	Beleſby - - -	—	—	4	5	—	—	4½	3
	Humberſton - -	2½	3	4	3	7½	4	4½	3½
	Saltfleet - -	—	—	—	—	—	10		
Marſh land.	Louth - - -	3	—	5	—	7	—	5	
	Dalby - - -	3½	3	5	4	8	5½		
	Spilſbury, Mr. Wright	3½	4	4	5½	5½	7½		
	Welton - - -	—	3½	—	—	—	—	—	3
	Ditto - - -	—	2½						
Clay and marſh land.	Skirbeck - -	2½	3¼	—	—	5	7½	4	3½
	Reeveſby - -	3½	2½	4	3¾	5	5		
	Mr. Parkinſon -	2	3	2	4½	4	8		
	Ranby - -	3	3	4	3½	6			
	Ditto - - -	—	—	—	2½	—	4		
Strong land.	Mr. Elmhurſt -	4	5	4	6				
	Swinop - - -	3½	3	4	4½	6	5		
	Mr. Elliſon - -	2½	3	4	4	6	5		
	Claypool - - -	3	3¾	3¾	4¾	—	—	2	4¾
	Woolſthorpe - -	2½	3½	3	4½	6	6		
	Grimſthorpe - -	2¼	3¼	3	4½	6	5	2¾	4
	Average -	3	3½	3¾	4¼	6	6½	3¾	3¾

But though the proportions of ſeed that may be the moſt proper and advantageous for affording the fulleſt and moſt abundant crops in different caſes, and under different circumſtances, have not yet been decided by the aid of experimental inveſtigation, the only method that appears capable of affording any degree of certainty on the ſubject; there is ſtill another point that ſhould never be overlooked by the correct agricultor, which is that in ſowing ſeed that is known to be good and perfect in its quality, a leſs quantity will always be ſufficient than where the contrary is the caſe, as in the former inſtance almoſt every ſeed will vegetate, while in the latter, many muſt prove faulty.

The time of ſowing, or putting crops into the ground, is evidently a matter that muſt depend in a great meaſure upon their economy and the peculiarity of their nature. Hence the moſt proper and advantageous ſeaſon for ſowing or ſetting ſuch as poſſeſs the habit or are capable of perfecting and ripening their ſeed or produce in the ſame year, is that of ſome of the more early ſpring months, according as they are more forward or late in their kinds, and the clime more mild, or the contrary; while in ſuch as are, from the peculiarity of their nature or habits, incapable of completing their vegetation in the ſame year, the moſt favourable period will be ſome of the more early autumnal months, according to the differences of their habits, and the variations of climate and ſeaſon; as by theſe means in the former caſe the ſeeds, grains, or roots, become perfectly evolved, and the radicles of the young plants firmly eſtabliſhed in the ſoil, and capable of ſuſtaining themſelves againſt the hot ſeaſon ſets in which is to bring them to maturity; and in the latter the ſeeds have attained ſuch a ſtate of growth, and ſo far fixed their roots in the ground, as to be capable of ſupporting themſelves without ſuſtaining much injury from the ſeverity of the winter ſeaſon, and conſequently advance with greater rapidity in their vegetation in the ſpring, in order to perfect their ſeed by the heat of the ſummer ſeaſon.

It has, however, by ſome cultivators been particularly adviſed to adopt the practice of ſowing certain ſorts of grains and ſeeds, and alſo of ſetting particular kinds of roots, at much earlier periods in the ſpring than is commonly had recourſe to by the farmer. Thus by putting barley into the ground in the beginning of February, great advantage has been ſuppoſed to have been derived in the forwardneſs and fineneſs of the grain *.

Againſt this method it is, however, ingeniouſly ſuggeſted, that as much

* Lord Orford in Young's Annals of Agriculture, vol. IX. p. 389.

moiſture, with or without ſubſequent froſt, is more liable to deſtroy the embryo in its very early ſtate in the ſeed than after it has ſhot out roots and a ſummit, and thus acquired ſome habits of life, ſuch early ſowing muſt in ſome caſes be practiſed with caution *. Such an objection cannot, however, be brought againſt the early autumnal ſowings. The ſame philoſophical writer alſo remarks, that the difficulty of determining the beſt ſeaſon for ſowing ſeeds in the ſpring, owing to the variation of the weather in the ſame latitude, as well as of laying down the exact ſeaſons for ſowing in different latitudes, occaſioned Linnæus to conſtruct what he terms a calendar of Flora, which was afterwards adapted to this climate by Stillingfleet; which conſiſted in obſerving the firſt appearance of the root-ſcions, or flowers of the uncultivated native vegetables, with directions to ſow the *cerealia*, or harveſt ſeed, when ſuch plants or flowers became viſible. By attention to obſervations of this kind on ſuch ſorts of uncultivated plants in many climates, it is conceived ſuch tables might be conſtructed as would point out the moſt proper times of ſowing the moſt uſeful ſeeds or grains in every latitude and ſituation. And it is added, that another tabular view of the climates where plants grow naturally, and of their native ſituations in reſpect to moiſture or dryneſs, hill or valley, with the kind of ſoil where they were originally found, might alſo contribute to their ſucceſsful cultivation.

The above ſeem to be the objects of nature in the vegetation of ſeeds, in requiring ſuch different lengths of time for arriving at maturity. The particular period in which each ſort of grain, ſeed, or root, may be ſown, or put into the earth, with the greateſt proſpect of ſucceſs, will be noticed when we come to ſpeak of the manner of cultivation in the growth of the different ſorts.

In the depoſiting of ſeeds or roots in the ſoil, it may be neceſſary to pay ſome regard to the depth to which they may be introduced and covered; as upon theſe being ſuitably performed according to the nature of the ſeeds or roots, the qualities of the lands, and the ſtate of the climate, different advantages may be obtained in the early vegetation and ſubſequent growth of the crops.

In ſuch ſeeds or roots as are to be put into the ground in the ſpring months, as there is generally a large proportion of moiſture in the ſoils from the continued rains of the autumnal and winter ſeaſons, it may be unneceſſary to cover them to any great depth; half an inch or an inch may at moſt be ſufficient, ſo as to fully protect them from birds and inſects, for grain, turnip, carrot, and

* Darwin's Phytologia, p. 461.

other ſimilar ſeeds; and for roots, ſuch as potatoes, and others of the ſame kinds, from two to three or four inches, according to circumſtances, may be as much as is requiſite. But, in the early autumnal ſowings, as, from the great diſſipating heats of the ſummer months, there muſt in general be leſs humidity in the earth, it may be uſeful in ſuch circumſtances to have the ſeed buried ſomewhat deeper, as two inches or more, in order that their vegetation may not only be more ſpeedily effected, but their roots more fully guarded from the effects of the froſty nights, which uſually take place ſoon after ſuch ſowings. Beſides, they will thus be more effectually protected from the attacks of birds and other vermin, which are generally more eager and deſtructive from the diminiſhed quantity of food at ſuch periods.

But in general, as we have already ſeen that the proceſs of ſprouting or early vegetating is greatly promoted by the ſeeds being fully ſupplied with oxygen air, it may be the moſt beneficial practice to have them but lightly covered or put into the ſoil, in rather a ſuperficial manner, as by ſuch means they will be the moſt fully ſupplied with atmoſpherical air. And on this account too it may be the moſt advantageous method to have the ſeeds or roots depoſited in the ſoil as ſoon as poſſible after it has been turned up by the plough or the ſpade, as in ſuch circumſtances it muſt, as has before been noticed*, contain the largeſt proportion of atmoſpherical air among its conſtituent particles; which it is obſerved may be neceſſary to ſtimulate into elevation the plume of the embryo plant, as the moiſture of the earth is neceſſary to ſtimulate the root into its elongation downwards †, or in other directions.

The depths of ſuch ſowings may be the moſt perfectly regulated by the uſe of drill machines.

The ſtate of the ſeaſon, and climate, in which grain ſeeds or roots are put into the ſoils, may likewiſe have ſome influence on the crops, as has in part been already explained.

It has been generally ſuppoſed that the beſt practice is that of ſowing in dry ſeaſons, and ſetting out plants in ſuch as are moiſt; but it is obvious that, in ſo far as the ſowing is concerned, this buſineſs ought, in ſome reſpect, to be conducted according to the differences of the qualities of the lands, and the nature of the climate in regard to its warmth, or the contrary. Thus in the drier and more mellow and porous deſcriptions of ſoils, and the more warm and genial climates, it may in many caſes be advantageous not only to ſow in the wet, or rather moiſt ſeaſons, but alſo at more early periods than in ſuch as are more

* Section on Fallowing of Land. † Darwin's Phytologia, p. 461.

retentive of humidity; as from the moiſture being commonly, in ſuch ſorts of land, quickly diſſipated, a more certain and expeditious vegetation of the ſeed may in this way be ſecured.

But in the more heavy and wet kinds of ſoils, where the climate is colder, it will conſtantly be a more beneficial method to chooſe, if poſſible, a dry and warm ſeaſon for performing the buſineſs of ſowing or putting in the crops, as by ſuch means the grain will be more certain of vegetating, and in leſs danger of periſhing by the overabundant wetneſs, and the want of heat, in ſuch lands and climates. And it has been well remarked, that in ſome clayey grounds much ſoftened by rain, if the ſeed be put into holes, and a dry ſeaſon ſucceed, an almoſt impenetrable cruſt may be produced by the quick exhalation of the moiſture, and what is termed by farmers the ſetting of the clay*; and in this manner the vegetation and early growth of the crop be much retarded, or in a great meaſure prevented.

Though it has been ingeniouſly ſuggeſted, that uſeful purpoſes in the early vegetation of ſome ſorts of plants may be anſwered by the ſowing of the fruits or huſks that ſurround particular kinds of ſeeds and berries†, no experiments have yet been made to ſhew whether the ſowing the chaff, or covering of the grain with it, might not, in particular circumſtances of ſoil and climate, be of utility in affording it warmth and protection in the firſt ſtages of its growth.

In regard to the nature of the ſoils, and the crops or kinds of ſeeds, or plants, that may be cultivated upon them with the greateſt chance of profit and advantage, it may be generally obſerved, that theſe may be the beſt and moſt perfectly adapted to each other, ſo as to afford the moſt abundant and moſt valuable produce, by attentively obſerving what ſorts agree moſt fully in the nature of their nutritive properties, their ſtates of moiſture, their condition in reſpect to pulveriſation or mellowneſs, and their ſituations in regard to warmth. Thus on all the more light and friable deſcriptions of ſoil, ſuch as thoſe of the ſandy, gravelly, chalky, and mellow loamy kinds, barley, oats, peas, turnips, carrots, and various other ſorts of green crops, as well as thoſe of grain, may be ſucceſsfully cultivated; while thoſe of the heavy, gravelly, chalky, loamy, marſhy, and ſtiff clayey, will be more ſuited to the growth of wheat, oats, beans, clover, ſaintfoin, and other ſorts of graſſes of the artificial kind, as will be more fully ſeen when we come to ſpeak of the rotation of crops, and the methods of cultivation that appear to be the

* Darwin's Phytologia, p. 465. † Ibid.

moſt proper for each kind of crop. But in this buſineſs, beſides the properly adapting the nature of the crop to that of the ſoil, as tillage lands are liable to be injured by the repeated growth of particular ſorts of crops, as thoſe of the grain kinds, there is another circumſtance that ought invariably to be kept in view, which is that of preventing the exhauſtion or deterioration of ſuch lands by the judicious and attentive interpoſition or alternation of ſuch as are ameliorating, either by their ſhade or other properties, or but of a ſlightly exhauſting nature, with ſuch as are more powerful in robbing the ſoil of its nutritious properties; ſuch as thoſe of the green, and which are often termed cattle, kinds, with thoſe of the white or corn kind. In this way, beſides the prevention of injury, in ſo far as reſpects the exhauſtion of the ſoil, advantages may alſo be gained by the land, from the different means of tillage which are thus required.

In regard to the practice of ſowing or putting the ſeed into the earth, different methods are followed, not only in diſtricts where the nature and qualities of the ſoils are different, but in thoſe in which they have much ſimilarity. The moſt general and common mode, as well as that which is more or leſs prevalent in almoſt every part of the kingdom, is that of ſowing or caſting the ſeed over the ſurface of the ground by means of the hand, having it afterwards covered to a proper depth by harrowing. In this method of performing the buſineſs, the moſt uſual practice, eſpecially where the ridges are equal in breadth, and not of too great a width, as five or ſix yards, is that of diſperſing the ſeed regularly over each land or ridge, in once walking round; the ſeedſman, by different caſts of the hand, ſowing one half in going and the other in returning. In doing this, it is the cuſtom of ſome ſeedſmen to fill the hand from the baſket or hopper, which they carry along with them, as they make one ſtep forward, and diſperſe the ſeed in the time of performing the next; while others ſcatter the ſeed, or make their caſts, as they are termed by farmers, in advancing each ſtep. It is evident, therefore, that in accompliſhing this buſineſs with regularity and exactneſs, upon which much of the ſucceſs of the crop muſt depend, there is conſiderable difficulty, and the proper knowledge and habit of which can only be acquired by experience. Wherever this method of putting in the ſeed is had recourſe to, it is conſequently of importance for the farmer either to perform the operation himſelf, or to be careful in ſelecting ſuch perſons as are converſant with the buſineſs, as he may otherwiſe

incur much unneceſſary expence in the waſte of ſeed, and run conſiderable riſk in reſpect to his crops.

It has indeed been well obſerved, that in this way of ſowing, even with the moſt expert ſeedſmen, where the lands or ridges are irregular or broader at one end than the other, a conſiderable waſte of ſeed muſt always be the conſequence; as when turning repeatedly on the ſame ridge, and at different parts, they cannot poſſibly ſcatter the ſeed with equal regularity as if it was of the ſame breadth, and they could regulate their caſts by the line of a particular furrow-ſlice *.

From the ſeed in this kind of ſowing being ſcattered at random over the ground, and of courſe vegetating or coming up without any regularity on every part of the land, the crops cannot derive any great advantage in their growth by after-culture, except in the way of clearing them from weeds by the hand, or ſome other ſimilar means; but in other methods this is not the caſe, as they can be much improved by hoeing and other means.

It is probably from the eaſe and expedition with which crops are put in, in this mode, its requiring little knowledge or expence of machinery, and the buſineſs being capable of being performed in almoſt every variety of ſeaſon, as well as circumſtance of ſoil and preparation, that it prevails, in ſome meaſure, in moſt parts of the iſland. It is evident, however, that it is a leſs perfect, as well as leſs economical, method of practice, in many reſpects, than thoſe that are deſcribed below, as the ſeed can neither be depoſited in the ſoil with the ſame exactneſs in regard to depth, regularity, or proportion, nor be ſo placed as that the crop may be improved in its growth by culture afterwards. It may, notwithſtanding, be practiſed with propriety and advantage in caſes where the nature of the land is ſuch as not to admit the more perfect methods, either from their being ſo extremely ſtrong and ſtony, or ſo very ſtiff and tenacious, as to greatly impede and diſturb the progreſs and operation of the machinery which is employed, or from the ſtate of the ſeaſon being ſo wet as to prevent the land from being ſown by ſuch means. Thus in ſoils that abound much with ſtones; that are very ſtiff, wet, and clayey; and in all ſuch probably as have been but recently broken up, and are not yet reduced by tillage to a ſtate of conſiderable fineneſs in reſpect to their mold; this method muſt be had recourſe

* Donaldſon's Modern Agriculture, vol. II. p. 267.

to as being the moſt ſuitable and convenient. And there is another ſituation in which it muſt probably of neceſſity in many caſes be practiſed; which is that in which the extent of ground cultivated under the drill ſyſtem is ſo very extenſive as to prevent a due attention being paid to the after-culture of the crops, by its interfering with the other neceſſary operations of the farm. In caſes of this ſort, as much depends upon the after-management where machinery is made uſe of, it will probably always be better to have ſuch portions as cannot be properly attended to ſown in the broadcaſt method.

This method of ſowing, probably from its being that which was almoſt generally had recourſe to during the infancy of the art of agriculture in this country, has frequently been denominated the *old method*, in oppoſition to that which was afterwards introduced by Mr. Tull. There is, however, reaſon to ſuppoſe that the method introduced, deſcribed, and recommended by that intereſting writer, is not ſo *new* as it has been commonly believed to be; for it has been lately found that it is generally practiſed in the Innacondah diſtrict in the Eaſt Indies, in the culture of all grains except horſe grain, as well as in that of hemp, tobacco, cotton, and the caſtor-oil plant*; and it is ſaid that they both drill and dibble corn of every kind in Arabia, China, and Japan, where their ſyſtem of huſbandry has not undergone any material alteration for thouſands of years.

In the drill method of ſowing, the grain or ſeed is depoſited, by means of ſome ſort of machinery or other, in rows or drills at different diſtances, according to the nature of the crop and the views of the farmer. It of courſe affords the means of diſtributing the ſeed with a much greater degree of exactneſs, both in reſpect to the depth and the regularity of the rows, by which the crops not only vegetate and grow up in a more equal manner, but by cultivation are capable of being more effectually aſſiſted in their after-growth, and at the ſame time there is a conſiderable ſaving in the quantity of ſeed. And as the grain by ſuch means is neither too thickly crowded together, nor too thinly ſcattered in the drills, there cannot be any injury in the weakneſs of the crops from the former cauſe, or loſs from the too ſcanty number of ſtems and ears in the latter, which muſt always be more or leſs the caſe in the broadcaſt method of management. Beſides, from the equality of the depth to which

* Halcott in Communications to the Board of Agriculture, vol. I. p. 350.

the ſeed is depoſited in this way, in addition to the advantages that have been juſt noticed, the crops become ripe in a more equal and uniform manner.

In the aſſiſting of the growth of the crop by the frequent ſtirring and breaking of the earth about it, for a conſiderable part of the time it is upon the ground, benefits muſt alſo be derived in different ways. By turning the earth in different directions, the mold muſt become, not only more completely pulveriſed, but alſo newly and more fully aërated, in conſequence of which various nutritious materials muſt be more abundantly provided*; while, at the ſame time, the ſoil is rendered more eaſily penetrable by the ſuperficial roots of the grain, and the power of tillering or ſending forth new roots and ſtems increaſed by the earth being laid up to ſuch of the joints of the corn ſtems as are immediately above the ſurface. By this means the ſame advantages are, indeed, in ſome meaſure obtained, as by tranſplanting and ſetting the roots of the plants deep in the earth, with conſiderable ſavings in the expence of labour. There are likewiſe other ways in which utility may be derived in this method of management, as by the more complete deſtruction of weeds that takes place, and the harveſting of the crops, in conſequence of it, being acompliſhed with more certainty and leſs trouble and expence, as well as by the land being left in a more mellow and productive ſtate for the growth of future crops †.

From the fine ſtate of pulveriſation in which the ſoil is kept by this method, and its being more free from weeds, advantages may ſometimes alſo be gained in the way of preparation for putting ſucceeding crops into the ground, which could not otherwiſe be the caſe.

But though this method of ſowing ſeems to afford advantages in theſe different views, it has not by any means been generally adopted by agricultors, the reaſons of which, as ſuggeſted by an ingenious writer, are the difficulty of bringing common labourers acquainted with the practice, the incorrectneſs of the machinery commonly employed in delivering the ſeed, and the expence with which it is at firſt attended; but there are others which have probably had an equal if not greater effect in retarding its progreſs, as the applying it to lands in an improper condition, both in reſpect to quality and the ſtate of tillage, and the either wholly or partially neglecting the after-management of the crops, upon which, it is obvious, much muſt

* Section on Fallowing of Land. † Exter in Memoirs of the Bath Society, vol. IX.

depend. It is probable alſo, that by attempting too great ſavings in the quantity of ſeed, and allowing it to be ſown too thinly, both in reſpect to the drills and the diſtances of the rows, the practice may in many inſtances have been brought into diſrepute.

It is, however, ſufficiently ſhewn by numerous comparative experiments *, that where the nature of the ground and the ſtate of tillage are ſuch as to admit the implements to perform the buſineſs in a proper manner, and where a proper and regular attention is beſtowed on the after-management of the crops, it is a method that has not only advantages in the ways that have been mentioned, but much ſuperiority in the quantity and quality of the produce, as well as the more perfect tillage of the land.

The ſorts of land on which this method of putting in the ſeed may be had recourſe to with the greateſt probability of ſucceſs, are all thoſe of the lighter and more mellow kinds, that are not ſo ſtrong as to obſtruct or impede the operation of the drill, and ſuch of the heavy deſcriptions as have been brought into a ſtate of tolerable fineneſs, and are not too wet or ſtiff to hinder the action of the machine; but it can probably ſeldom or ever be employed to much advantage, except, perhaps, for ſome particular ſorts of crops, on thoſe of the heavy and ſtiff, wet, clayey, kinds, as the operation muſt always be liable to be incompletely performed; nor on ſuch as are of a very ſtony nature can it be made uſe of in a proper manner, as the ſtones will conſtantly be liable to derange the operation of the drill, and render the diſtribution of the ſeed irregular and incomplete.

In very wet ſeed ſeaſons too, it muſt, perhaps, give way in many caſes to the broadcaſt method, eſpecially on the wet and heavy deſcriptions of land, as under ſuch circumſtances the operations of the drill would ſcarcely ever be performed with that regularity and exactneſs which is neceſſary.

But in whatever kind of ſoil, and wherever the method of ſowing by the drill is attempted, it will invariably be proper, beſides ſuiting the crop to the quality of the ſoil, to proportion the quantity of ſeed to the nature of the land, and the diſtance of the rows to that of the crop, and likewiſe keep up a conſtant and minute regard to the culture of the crop during its growth.

In the ſowing of crops by means of drill machines, different diſtances in the rows and intervals have been recommended, according to the particular intentions of the agricultor. It is obvious that inconveniences muſt be experienced by their

* Amos on Drill Huſbandry.

being either too large or too narrow, as in the former there muſt be a great loſs of ground, and in the latter little advantage can be derived in the culture of the crops, while growing. The nature of the land muſt probably have conſiderable influence in regard to the diſtance of the rows, and the manner of drilling. On the dry light ſorts of ſoil, whether loamy, gravelly, or chalky, that can be conſtantly ploughed and kept upon the flat, as is the cuſtom in the eaſtern parts of Kent, cloſe drilling is probably to be preferred as the moſt advantageous *. But on ſuch ſoils as require ridging, ſomewhat wider diſtances may be proper. An ingenious enquirer on this ſubject found, that drilling three rows eleven or twelve inches aſunder, on three-bout ridges, generally ſucceeded well. The three-bouts, in this way, form a ridge about four and a half feet in breadth; the three rows at the diſtance mentioned occupying two feet, and the horſe-hoe, paſſing on the ſide of each outſide row, at the diſtance of three inches, leaves the ridge two and a half feet broad, and the intervals between the ridges about two feet †. It is, however, further ſuggeſted, from remarking that in theſe caſes the outſide rows always afford the moſt vigorous and healthy plants, that two rows only, on two-bout ridges, would be equally productive, and leave the land in better condition.

But whatever may be the moſt applicable and moſt ſuitable diſtances, which experiment does not ſeem to have yet fully ſhewn, the very wide intervals of the early practice are to be avoided as improper for all ſorts of grain crops, both on account of the loſs that muſt unavoidably be ſuſtained by the largeneſs of the ſpaces, and becauſe the intervals, or ſpaces between rows, at much leſs diſtance, can, in the improved methods of horſe-hoeing, be ſtirred with equal facility and exactneſs.

For various kinds of green crops, ſuch as cabbages, potatoes, and others of a ſimilar nature, wide diſtances muſt obviouſly be the moſt proper. But the width of the intervals, and the proportion of ſeed, that have appeared the moſt elegible to an intelligent cultivator, after a practice of fourteen or fifteen years, are for wheat, rye, barley, oats, and vetches, on ſuch ſoils as are not very wet, equidiſtant rows of one foot, on five or ten feet ridges. And for beans, peas, and turnips, on three-feet ridges, two rows on each, nine inches apart, with intervals of twenty-ſeven inches ‡.

* Farmer's Tour through the Eaſt of England, vol. IV. p. 215.

† Wimpey in Tranſactions of Bath Society, vol. VI. p. 126.

‡ Cloſe in Communications to the Board of Agriculture, vol. III.

In reſpect to the proportion of ſeed, it is obſerved, that ſuch lands as are in high tilth, and on five-feet ridges, will only require three pecks of ſeed of either wheat or rye, five pecks of barley, oats, or vetches, and one buſhel of beans or peas, to the acre. It is ſuggeſted, however, that theſe proportions ſhould be varied, in the quantity of a peck to the acre, according to the quality of the ſeed, and the richneſs of the land.

It is remarked by another experienced driller, that in reſpect to wheat and barley, the diſtance of the rows and the quantity of ſeed muſt greatly depend on the quality of the ſoil. Where it is poor, the diſtance between the rows ſhould not be more than about eight inches, nor the quantity of ſeed more than about nine pecks, being depoſited to the depth of two inches and a half. If of a middling quality, the diſtance between the rows may be about nine inches, and the proportion of ſeed eight pecks; and where it is rich, the diſtance of the rows ſhould not ever exceed ten inches, with a quantity of ſeed of about ſeven pecks. The latter ſort of grain ſhould alſo have a finer tilth, and not be placed ſo deep in the ſoil.

As oats do not tiller ſo much as other grains, in drilling them a larger proportion of ſeed will be requiſite*.

It is likewiſe ſtated by the ſame writer, that as beans and peas afford plants of a very ſucculent nature, they of courſe require a greater diſtance between the rows, and more eſpecially as they are well ſuited to the horſehoeing method of culture. He has conſtantly found twenty-four inches to be the moſt advantageous diſtance for ſuch crops, and the depth of about three inches.

In the ſowing of turnips, rape, &c. on the poorer ſorts of ſoils adapted to the growth of theſe plants, he has invariably found ten inches to be the propereſt diſtance, and on thoſe of the richer deſcription twelve. When they are ſown at greater diſtances, he thinks they are apt to grow too large for keeping any great length of time. If ſown at a wider diſtance, which may, notwithſtanding, be proper on ſuch ſoils as are particularly rich, they ſhould therefore be eaten off before the ſevere froſts ſet in, as large turnips are very liable to be deſtroyed by them.

In the putting in of carrot crops by the drill method, fourteen inches between the rows is recommended as the moſt proper diſtance, the land being ſlightly harrowed over after the drilling is finiſhed †.

* Amos on Drill Huſbandry, p. 190. † Ibid.

The result of Mr. Arthur Young's enquiries, as ſtated in his Eaſtern Tour, reſpecting the influence of different diſtances on the produce in various kinds of crops cultivated in the drill or row method, is fully ſhewn in tabular views of different ſorts of grain, &c. *

* Wheat.

Crops.	Diſtance.	Produce. Q.	B	
Mr. Fellowes . .	Eighteen inches .	2	5	
Mr. Arbuthnot .	Four rows, at eight inches on 3½ feet ridges	2	1	Horſe-hoes
Mr. Taylor . .	Ten inches . .	4	0	Ditto
Mr. Reynolds . .	Twelve ditto . .	2	4	
Thanet . . .	Nine ditto . .	4	0	Ditto
Ditto . . .	Equally diſtant . .	3	4	Ditto
Mr. Anderſon .	Two rows on 5 feet	1	4	Ditto
Mr. Cowſlade . .	Eighteen inches . .	3	4	Hand-hoes
Ditto . . .	One foot . .	3	4	
	Average .	3	1	

Barley and Oats.

Crops.	Sort.	Diſtance.	Produce. Q.	B.	
Mr. Arbuthnot . .	Barley	Double rows, 3, 4, and 5 feet ridges	1	7	Horſe-hoes.
Mr. Taylor . . .	Oats	Eleven inches . .	4	4	Ditto
Thanet . . .	Barley	Nine ditto . . .	5	4	Ditto
Ditto . . .	Ditto	Ditto	5	4	Ditto
Ditto . . .	Oats	Ditto	7	0	Ditto
Mr. Pool . .	Barley	Nine inches . . .	6	0	Hand
Mr. Anderſon . .	Ditto	One foot . . .	3	0	
Ditto . . .	Oats	Ditto	3	3	
		Average .	4	4	

Beans.

Crops.	Diſtance.	Seed.	Produce. Q.	B.	Following Crops.
Lemington . .	. . . .	. .	4	0	Wheat
Mr. Canham . .	Every fourth furrow	2½	5	4	Ditto, five qrs.
Saxmundham . .	. . . .	. .	4	4	
Woodbridge . .	Sixteen or 18 inches	. .	6	2	Wheat
Colcheſter . .	Nine inches . .	. .	6	4	Ditto
Mr. Arbuthnot . .	Various . . .	2	3	3	Ditto
Dartford . .	. . . .	. .	5	0	Ditto
Northfleet . .	. . . .	. .	6	0	Ditto
Sittingburn . .	. . . .	. .	6	4	Ditto
Feverſham . .	Eighteen inches .	. .	5	4	Ditto
Beakſburn . . .	Twenty inches . .	. .	5	0	Ditto

Mr. Taylor

Since theſe tables were drawn up, many improvements have, however, been made, not only in the mode of drilling itſelf, but likewiſe in the implements that are made uſe of for the purpoſe, by which conſiderable effects muſt have been produced, both in regard to the quantity and the goodneſs of the produce of crops under the row culture *.

There is, notwithſtanding, conſiderable difficulty in aſcertaining the moſt proper and ſuitable diſtances in different caſes, as they muſt of neceſſity depend

* Farmer's Tour through the Eaſt of England, vol. IV. p. 197.

BEANS (*continued*).

Crops.	Diſtance.	Seed.	Produce. Q.	B.	Following Crops.
Mr. Taylor . .	Double rows, ſixteen inches on 4-feet ridges.	. .	4	0	Barley
Preſton . . .	Eighteen to 24 inches	. .	5	0	Wheat
Thanet . . .	. . . .	. .	4	4	Ditto
Ditto . . .	Sixteen to 24 ditto	. .	4	4	Ditto
Ditto . . .	. . . .	. .	4	0	Ditto
Dover . . .	Eighteen ditto	. .	4	0	Ditto
Sandgate . .	. . . .	. .	4	0	Ditto
Mr. Turner . .	. . . .	. .	5	0	
Mr. Anderſon . .	. . . .	. .	1	3	
Donnington . .	Eighteen ditto	. .	4	4	
Mr. Cowſlade . .	. . . .	. .	4	4	
	Average .		4	4	

PEAS.

Crops.	Diſtance.	Produce. Q.	B.	Following Crops.
Tring . .	Two feet . .	4	3	Wheat
Mr. Booth . .	. . . .	1	4	
Woodbridge . .	. . . .	3	4	
Colcheſter . .	. . . .	4	0	Wheat
Mr. Neal . .	Ten inches . .	3	0	
Dartford . . .	. . . .	5	0	Wheat
Northfleet . .	. . . .	5	4	Ditto
Sittingburn . .	. . . .	3	4	Ditto
Beakſburn . .	Twenty inches .	3	4	Ditto
Thanet . .	Sixteen to 24 inches	4	0	Ditto
Ditto . . .	. . . .	4	0	Ditto
Mr. Anderſon . .	Twenty inches .	1	1	
Mr. Coombs . .	. . . .	3	6	
Donnington . .	Fifteen inches .	4	0	
Mr. Cowſlade . .	. . . .	4	4	
Reading . . .	Eighteen inches .	3	4	
Harleyford . .	. . . .	3	4	
	Average .	3	5	

in a great meaſure upon the nature and ſtate of the ſoil, as well as that of the crops.

It is obvious, however, that for grain crops, ſuch as wheat, barley, &c. from the vaſt loſs of ground that muſt take place, the great diſtances practiſed by Tull can ſeldom if ever be had recourſe to with advantage. The experience of drillers in general ſeems indeed to have ſhewn, that on moſt ſorts of ſoil that are ſuited to that method, and eſpecially thoſe of the light and dry kinds, the drilling in cloſe rows, or at narrow diſtances, is by much the moſt beneficial mode. It has been obſerved, in reſpect to the firſt practice, or that of rows from three to four or five feet apart, that if after a period of eighty years it has been capable of making few converts to continue it for any length of time, the preſumption is, that there is ſomething wrong in either the principle or practice; and if the former be juſt, which cannot be diſputed, the error muſt be in the practice *. Others have likewiſe contended, that though the method of cloſe rows is advantageous, the broadcaſt plan greatly exceeds the ſyſtem of wide intervals †.

The diſtances between the rows, and the proportions of ſeed to the acre, that have been found by an experienced drill cultivator to afford the beſt and largeſt crops, are from eight to twenty-eight inches in the intervals, and from ſeven or eight to ſixteen pecks of ſeed, according to the quality of the land and the nature of the crop ‡.—Some latitude may, however, be admitted, as the circumſtances of the caſe vary ‖.

A very able and intelligent agricultor, who has paid much attention to the cultivation of crops in drills, has from great experience found, that for white corn crops nine inches anſwer extremely well, but that for peaſe, tares, turnips, and other ſimilar crops, eleven inches is the diſtance that ſucceeds the beſt, and that for beans eighteen inches are not more than is neceſſary ¶. It has likewiſe been found in reſpect to this laſt ſort of crop, by others accuſtomed to the row

* Donaldſon's Modern Agriculture, vol. III. p. 93.

† Farmer's Tour through the Eaſt of England, vol. IV. p. 215.

‖ Amos on Drill Huſbandy, p. 207.

¶ Cloſe in Communications to the Board of Agriculture, vol. III.

‡

Kind of ſoil.	Wheat.		Barley.		Oats.		Beans.	
	Quantity of ſeed.	Diſtance between the rows.	Quantity of ſeed.	Diſtance between the rows.	Quantity of ſeed.	Diſtance between the rows.	Quantity of ſeed.	Diſtance between the rows.
	Pecks.	Inches.	Pecks.	Inches.	Pecks.	Inches.	Pecks.	Inches.
Pooreſt	10	8	12	8	16	8	12	18
Poor .	9	8	10	8	14	8	10	20
Rich . .	8	9	8	9	12	9	9	24
Richeſt .	7	10	7	10	10	10	8	28

ſyſtem, that when drilled in two rows at nine inches, with an interval of twenty-ſeven, if weeded ſufficiently early, and ploughed between in the method recommended by Mr. Cook, it becomes extremely thick and fine *.

When clover, or other graſſes, are grown with barley crops, it has been aſcertained by long experience by an ingenious cultivator, that the moſt ſure way of obtaining ſuch graſs crops, without the barley being injured, is that of ſowing the graſs ſeeds juſt before the laſt horſe-hoeing. The barley in this method being twice horſe or hand hoed, previous to ſowing the ſeeds, will, it is ſuppoſed, not only be clear from annual weeds, but a fine tilth be obtained for the ſeeds; the blades of corn meeting over the intervals will protect the young plants from the depredations of the fly, and from the ſcorching ſun; the moiſture of every dew will be retained under the ſhade of the corn; and the ſeeds, by being ſown a month or ſix weeks after the barley, will never exhauſt themſelves too much the firſt ſummer, nor riſe ſo high as to interfere with harveſting the barley. It is added, that in a moiſt ſeaſon, when the ſeeds are ſown early with the barley, the land is frequently full of annual weeds; the young plants of clover are often taken off by the fly, and, if they flouriſh, expend themſelves ſo much, that when you expect a full and firſt crop of clover, you have ſomething like a ſecond year's cut, and many fields of barley have been rendered uſeleſs for all the purpoſes of malting, by having ſo large a portion of rich ſucculent clover in the crop, as to prevent their being harveſted †. The propriety of this practice appears alſo to be further confirmed by the ſucceſs of the ſame agricultor in drilling lucern between the rows of barley after the laſt horſe-hoeing, in the proportion of five pounds of ſeed to the acre. In this method the young plants were ſo protected by the ſhade of the barley, and ſo conſtantly kept moiſt by the dews, that it is aſſerted they ſuffered nothing from thirteen weeks dry weather ‡.

The practice of ſowing clover over the drilled barley crops, and covering it by the laſt hoeing, whether it be by the hand or horſe, has been long ſince conſidered of much importance, and far ſuperior to the uſual method of rolling it in §.

It is likewiſe evident, from the ſtatements of the firſt-mentioned writer ‖, that larger crops of barley may be procured by drilling with intervals of a foot,

* Exeter in Bath Memoirs, vol. IX.

† Cloſe's Eſſay in Communications to the Board of Agriculture, vol. III. p. 62. ‡ Ibid.

§ Farmer's Tour through the Eaſt of England, vol. IV. p. 213.

‖ In 1799, he ſays, he put a field, ſoil a ſtrong loam, on to three-feet ridges. In June of that year, he carted fourteen loads of long ſtraw dung, ſpread it in the furrows of thoſe ridges, and with one bout of the plough covered the dung, and formed the ridges over the furrows. On theſe he

than by the broadcaſt method; a point that has been much doubted by ſome cultivators.

In regard to the implements that are employed for the purpoſes of drilling, they are various, according as they are intended for the preparation of the land, for the putting in of the ſeed, or for the cultivation of the crops afterwards. In thoſe made uſe of for drilling, there is alſo conſiderable variety

planted cabbages two feet and a half from plant to plant, and three feet intervals. Theſe were ploughed between, horſe and hand hoed, and the crop a very good one. By Chriſtmas he had cut and carted the cabbages. He then levelled the ridges, and ploughed the land acroſs them ſeven or eight inches deep, with two horſes and a common Suffolk plough. Early in the month of April, 1800, he harrowed the land acroſs, with Mr. Cook's fixed harrow, the driver ſtanding on the harrow, and preſſing the tines four inches into the ſoil. A few ſurface weeds appearing, he ſkimmed the land, without turning a furrow, with the ſcufflers, followed by the roller; and then with the fixed harrow loaded as before, in a different direction, obtained a garden tilth five or ſix inches deep, as far as the froſt had penetrated; below which, the loam was wet and cold. From this land he obtained eight quarters one gallon of barley, weighing fifty-five pounds each Wincheſter buſhel; and two tons three hundred and thirty-three pounds of ſtraw. But as he was determined to aſcertain the money produce of his barley, he diſpoſed of the whole crop, though he never before ſold a load of ſtraw.

	£.	s.	d.
Seven quarters and a half of beſt barley, ſold at four pounds four ſhillings, .	31	10	0
Four buſhels of droſs ſold for	1	1	0
Two tons three hundred and thirty-three pounds of ſtraw ſold for . .	5	10	0
Produce of the acre	38	1	0

The produce of the whole field was, it is aſſerted, at leaſt equal to the acre which was meaſured; as a collateral proof of this, the tithe-owner refuſed three guineas per acre for the tithe of the barley, excluſive of the ſtraw.

It is ſtated that the trifling expence of tillage for obtaining this produce, eſtimating every horſe employed at two ſhillings per day, and every man at the ſame rate of wages, was only the following:

	£.	s.	d.
Firſt ploughing per acre, by two horſes	0	6	0
Harrowing per acre	0	0	9
Scuffling	0	1	0
Rolling with a five-foot roller	0	0	9
Harrowing	0	0	9
Drilling	0	0	9
Harrowing to cover the ſeed	0	0	9
Scarifying the corn, firſt operation	0	0	9
Second ditto	0	0	9
Horſe-hoeing	0	0	9
Rolling twice, after the corn was ſcarified . . .	0	1	0
	0	14	0

The

ariſing from the particular kind of crop that is to be ſown*. In the preparing of the land, and rendering it ſufficiently fine to admit the operation of the drill, beſides a common light *ſwing plough*, it will be neceſſary to be in poſſeſſion of a *cultivator*; that which is conſtructed and ſold by Mr. Cook, ſeems extremely well adapted to the purpoſe of breaking down and reducing the particles of ſtiff ſoils. It conſiſts of a diagonal beam, into which are inſerted a number of ſhares of different kinds, according to the uſe it is intended to ſerve, and from which, as has been already ſeen, it is differently denominated †. It is capable of being employed with different numbers of tines or teeth, as from three to ſeven, in proportion as the ſoil is in a clean or foul ſtate, or is of a light or tenacious quality. It is alſo well contrived for affording at once a conſiderable degree of pulveriſation to the ſoil, and at the ſame time of clearing it from the roots of weeds. It is ſtated by an intelligent cultivator, that as the chief deſiderata in tilling land are thoſe of pulveriſing, expoſing, cleanſing from weeds, and ridging up, in order to keep the land in a dry and healthy ſtate, and for the purpoſe of ſowing, they may every one of them, except the laſt, be fully at-

* Section on Implements. † Ibid.

The tillage to have only prepared the land for a crop of barley in the moſt approved method in Hants, would, it is ſaid, have been :

	£.	s.	d.
Two ploughings with four horſes, a man and a boy, at eleven ſhillings each per acre	1	2	0
The ſeed earth, with three horſes, a man and a boy	0	9	0
Three times dragging	0	3	0
Rolling once	0	0	9
Sowing ſeed	0	0	3
Harrowing, to cover ditto, with light harrows	0	0	6
Rolling once with a light roller	0	0	6
Expence of tillage, in the uſual method	1	16	0
Three buſhels of ſeed per acre, at the preſent price of barley	1	11	6
Expence of tillage and ſeed	3	7	6
In the new huſbandry tillage 0 14 0			
Seed ſix pecks 0 15 9			
	1	9	9
Advantage in tillage and ſeed in favour of the new huſbandry, per acre	1	17	9

It ſhould alſo be conſidered, he ſays, that the quantity of barley he uſually drills upon an acre is one buſhel, but being apprehenſive, from the wetneſs of the preceding harveſt, leſt the ſeed ſhould not all vegetate, he drilled ſix pecks. This land never before in the memory of man yielded more, it is remarked, than four quarters per acre.

tained at half the uſual expence, by making uſe of the *tillage ſcarifier* *. The ſurface weeds may be effectually eradicated and removed by ſkimming the land, by means of the broad ſhares or ſcufflers. The writer juſt mentioned alſo ſtrongly recommends an implement which he terms a *fixed harrow*, as being capable without any other tool of preparing lands that had been formed into ridges during the autumn or winter, for every ſort of corn crop of the ſpring kind. This is found to pulveriſe and reduce the ſurfaces of ſuch ſoils as have been expoſed to the action of the froſts, to the depth of four or five inches, without bringing up the cold unproductive earth that lies below.

The *extirpator*, deſcribed in the ſection on Implements, may likewiſe be employed for the ſame purpoſes with much advantage, as it is capable of reducing the ſuperficial parts of the ſoil into a fine condition, to ſuch depths as may be thought neceſſary, and at the ſame time of clearing it from weeds. It may be made uſe of on almoſt any ſort of land; and, from the particular nature of its conſtruction, is adapted to diſpatch much work in a ſhort ſpace of time.

When the land is of a ſtiff and lumpy, or cloddy nature, it may alſo frequently be neceſſary to have recourſe to *ſhims*, in order to break down and ſeparate the particles, and bring them into a leſs lumpy ſtate.

In ſome parts of the county of Kent, where the ſeed is ſometimes ſown without a drill machine, an implement is often employed which they term a *ſtriking plough*, by which little drills or channels are formed in the ground for the reception of the ſeed, about ten inches diſtant from each other, and at ſuch depths as are thought neceſſary for the particular ſort of crop that is to be ſown. It is uſually drawn by two horſes, one before the other, with two men, turning at the headlands alternately to the right and left. In order that the drills or channels may be parallel to each other, and of an equal diſtance, it is neceſſary to keep the inſide wheel in the middle of the outſide drill or channel. The work of from two to three acres may, it is ſaid, be performed in the courſe of a day with this tool.

The *drill roller* is likewiſe a tool applied for the ſame purpoſes, the rings with which it is ſurrounded forming the drills or channels in the ground. It may alſo, as has been ſeen †, be made uſe of to reduce the lumpineſs of ſoils.

There are a great number of machines of the drill kind in uſe, moſt of the drilling diſtricts of the kingdom being poſſeſſed of particular kinds that

* Cloſe in Communications to the Board, vol. III. p. 66. † Section on Implements.

are preferred by them. It has, however, been ſufficiently ſhewn in the ſection on Implements, that the chief points to be attended to are thoſe of ſimplicity of conſtruction, and their depoſiting the ſeed with regularity and exactneſs without bruiſing or in any way injuring it during the proceſs. Thoſe which appeared to us the moſt perfect in theſe views have been deſcribed, and may be ſeen by conſulting the plates.

An implement ſomewhat of this nature has been invented and uſed by Mr. Ducket, a very intelligent drill farmer, which has five ſhares, which ſtrike out as many drills or channels, on ridges prepared for the purpoſe, in the ground, into which the ſeed is equally delivered from a ſort of machine, termed a dropping box; or it may as in the above methods be broadcaſted into the ſmall furrows or drills made by the implement.

For drilling all ſorts of grain crops, the implements which have been already deſcribed are, ſo far as we have had opportunities of enquiring, the moſt perfect that have yet been invented*. Some of them, as that of Mr. Cook's invention, being very generally employed in many of the counties where drill huſbandry is practiſed.

A drill harrow, the invention of an ingenious agricultor†, who has made many uſeful experiments in drill huſbandry, from its great ſimplicity of conſtruction would ſeem to deſerve notice. It has ſomewhat the form of a triangular harrow, upon which are fixed two hoppers or ſeed boxes, the delivery of the grain or ſeed being performed by means of a fluted nut in the bottom of the hoppers, ſo adapted to the apertures as to work without the neceſſity of a bruſh. It is capable of ſowing eight rows at a time, at nine inches diſtance. There is a double row of deliveries put in a diagonal poſition, to which motion is communicated by means of a wheel. This is effected merely by a new application of the univerſal joint. It is ſaid to perform its work with much facility and exactneſs‡.

In addition to thoſe that have been already mentioned as adapted to the drilling of bean, pea, and other ſimilar crops§, it may be neceſſary to obſerve, that there are different ſimple implements conſtructed for regularly depoſiting theſe ſorts of ſeeds in drills or ſmall furrows. In the county of Middleſex, we have ſeen drills of this ſort made ſomewhat in the form of the very light ſort of ſwing ploughs; but without a coulter, having a ſmall kind of ſeed-hopper attached to the furrow ſide of the body of the plough, with the end

* Section on Implements. † Hutcheſon Mure, eſq.
‡ Young's Annals of Agriculture, vol. XXII. p. 361. § Ibid.

of the axle of a ſmall light wheel that runs on the landſide, paſſing through the loweſt part of it, and ſo contrived as to regulate the proportion of the ſeed according to the intentions of the perſon who has the management of it, and of being lifted up and prevented from ſowing at pleaſure. It may be drawn by one or two horſes, according to the nature of the land. It is ſaid to anſwer well, diſtributing the ſeed with much regularity and exactneſs.

An implement that differs in ſome reſpects from the above, but which has been found to be extremely uſeful for ſowing theſe ſorts of crops, has alſo been lately deſcribed in an intereſting periodical work *. The plan is perfectly ſimple. It conſiſts of a ſort of barrow or hopper, fixed between the ſtilts or handles of a ſmall ſwing-plough, which ſerves to draw the channel or furrow for the reception of the ſeed. The wheel, which in this drill is very ſmall, runs in the track formed by the plough-head, but ſo cloſe to it as not to be liable to be obſtructed or put out of its courſe by the intervening of clods or lumps of earth, as is often the caſe in other machines. It is capable of being prevented from ſowing at pleaſure by the wheel being raiſed, which is eaſily performed by means of a ſmall chain, which is attached by a pin to the right-hand ſtilt. The advantages of this application of the drill-barrow are aſſerted from actual trials to be, that while it is fully effectual in ſaving the labour of a perſon to wheel it, the ſeed is depoſited in the moſt regular and exact manner. This method of working the implement, it is obſerved, has been firſt practiſed by Mr. Lyon, a farmer, at Weſter-Drylow, in Mid-Lothian, on his own farm †.

It is likewiſe ſuggeſted, that a roller for ſowing turnip ſeed may be applied to the ſame implement.

It may notwithſtanding be obſerved, that in all theſe ſorts of drilling implements, one principal defect is, that of their only ſowing or depoſiting one row at a time.

There is alſo a ſort of ſmall *drill-plough* that may be of much advantage in the cultivation of turnip and other crops of a ſimilar nature, as it is ſo con-

* Farmer's Magazine, vol. II. p. 162.

† It is remarked in the above work, that this improved drill-barrow is made in a very correct manner, at the moderate price of eighteen ſhillings, by Meſſrs. Brown, coach makers, Abbey-hill, Edinburgh; who alſo will, if required, make an indented roller for planting potatoes by the ſame machine, which it is obſerved is now practicable from the new mode of cutting the ſeed by a ſpherical inſtrument, which, with the cutter itſelf, coſts three ſhillings more, and is made to fit the box in the ſame manner as the fluted roller for ſowing the beans, and takes out and may be put in occaſionally.

trived that a much greater depth of cultivated ſoil may be provided for the reception of the roots of the plants, than in the uſual methods, without the expence being in any way increaſed. In working it, one furrow is to be drawn ſtraight the whole length of the field, and the proper proportion of dung being then placed in it, every ſubſequent turn or bout of the plough is ſaid to form a new ridge, gather the dung, and bury it in the middle of it, and alſo make a drill, as well as depoſit the ſeed in it, and afterwards cover it, forming every ridge equally of the ſame height, and ſimilar in every other reſpect. In order to accompliſh this in the moſt perfect way, the land ſhould, however, it is obſerved, be in a fine ſtate of tillage. The plants being ſet out to ſuitable diſtances by drawing a common hoe acroſs the ridges, it will likewiſe, it is remarked, perform the buſineſs of hoeing in the moſt perfect and expeditious manner. It conſiſts of a ſmall wheel, with a ſeed-box, which is fixed on a ſpindle at the end of the axle, and in this way delivers the ſeed at the diſtance which is required; the whole is attached to a very light ſwing-plough. Where the ridges have been previouſly formed with two boxes, one at each end of the ſpindle, two rows may be conveniently ſown at a time. And if in the room of the hoe a plough with a double mold-board be made uſe of, with the ſame apparatus, the ridge is formed at the ſame time that it is drilled, one box only being made uſe of in this caſe.

As in diſtricts where the practice of ſowing grain or other ſorts of crops in drills or rows does not much prevail, there may frequently be a difficulty to comprehend the number and kind of implements of this ſort that may be neceſſary, it may be proper to afford ſome idea to the cultivator on the ſubject. It will, in general, be found that the nature of the ſoil, and the kind of crops that are to be grown, will have conſiderable influence in directing the choice of implements. It has, however, been ſuggeſted by an able cultivator who has had much experience in putting in different ſorts of crops in the drill method, that in order to keep one hundred acres of arable land in high tilth, and regularly cropped, two Suffolk ploughs, one cultivator complete, one beam and handles, with only the tillage ſcarifiers, one fixed harrow, one drill with corn ſcarifiers, and a ſet of flat hoes, with five horſes, would be required. And in addition, he would recommend two pairs of wheels with axes, independent of the drill wheels, which he would never uſe but for the purpoſes of drilling, except on very particular occaſions. Of other kinds of implements, he thinks it almoſt unneceſſary to mention that one ſtrong waggon, one of the light harveſt kind, with three dung carts, one common pair of harrows, and two rollers,

one very heavy but only about five feet long for the purpoſe of following the ſcarifiers, and another of the common ſort for paſſing over the corn crops in the ſpring of the year, would alſo be wanted. And it is added, that though the cultivator and fixed harrow may with propriety be conſidered as appendages to the drill, they are nevertheleſs applicable to the broadcaſt ſyſtem of huſbandry, and that if generally employed they would ſave more than one half the common expence incurred for tillage *.

In addition to the above, it is probable that in particular caſes ſome of the ſmaller ſorts of drills, ſuch as thoſe conſtructed for putting in bean, pea, and turnip crops, might alſo be neceſſary, as it is often troubleſome and inconvenient to employ the larger drills for ſuch purpoſes. Where a great variety of crops are cultivated, other ſorts of hoes beſides thoſe of the flat kind will likewiſe frequently be requiſite, as will be ſeen when we come to ſpeak of the nature of hoeing, and the kinds of implements beſt ſuited to the purpoſe in different caſes.

There is ſtill another method of putting the ſeed into the ground, beſides thoſe that have been already noticed, and which is certainly both ſimple and exact when attentively performed; but which, ſince drill machines have been brought to a greater degree of perfection, as it requires a great number of labourers, can probably be only employed to advantage in populous diſtricts, and where the value of labour is not high. This is that of dibbling or ſetting the ſeed ſingly by the hand, a practice that was known and ſlightly employed at an early period of the art in this country, and which has lately been reſtored by an intelligent agricultor †. It would ſeem to have been introduced into the county of Norfolk, where it has ſince been practiſed to a conſiderable extent, about twenty years ſince, by the cultivator of a ſmall farm in the vicinity of Norwich. Since that time it has extended itſelf into different neighbouring diſtricts, as thoſe of the counties of Suffolk and Cambridge, and is alſo ſaid to be practiſed in Lincolnſhire, with ſucceſs ‖. In this mode of putting the grain in, it is uſual where the land is of the light and mellow kind, to paſs a roller over it, before the buſineſs of planting is begun; the labourer then, with a ſmall iron-pointed dibble, about three feet in length, in each hand, makes in moving backwards two rows of holes in each furrow ſlice that has been turned up by the plough, at from four to ſix inches diſtant from each other, according to the circumſtances of the caſe, and

* Cloſe in Communications to the Board of Agriculture, vol. III. p. 67.

† Varlo's Yorkſhire Farmer. ‖ New Farmer's Calendar, p. 332.

about two or three inches apart in the rows, having the depth of from one to two inches. The perſon who is employed in making theſe holes is then followed by others who drop one, two, or three grains into each hole, as it may ſuit the intentions of the planter. This part of the work is moſtly performed by women and children. The whole is completed by running a buſh or light common harrow over the field *. In this way an expert dibbler, with three active aſſiſtants, is capable of ſetting half an acre of wheat, and three quarters of an acre of barley, oats, or peaſe, a-day †. For wheat, in ſome diſtricts, a narrow ſet-plough of only ſeven inches width at bottom, is uſed to plough with; a one-horſe roll then follows to level the flag, or furrow, for the dibblers, who ſtrike only one row upon each: when the wheat is depoſited, *two or three kernels in each hole*, a two-horſe roll follows, and afterwards the harrows twice in a place; when the field is finiſhed in this manner, it is harrowed up again obliquely: by this method the wheat is depoſited in the middle of the flag, at nine inches diſtance in the rows; and when come up, has the appearance of being drilled; the two-horſe roller is ſuppoſed of material uſe in cloſing up the holes, and preventing the wheat from being diſturbed by harrowing; and the land is made ſo ſolid by rolling, that very little apprehenſions are entertained about the ſlug or worm. If there ſhould be occaſion to hoe in the ſpring, the operation can be eaſily and cheaply performed. Buſh-harrowing is ſuppoſed of very little uſe; as it can only ſweep the duſt or light mold over the holes, and in the firſt ſhower of rain that follows moſt of them will be ſeen, and much of the wheat be ſwelled out of them ‡.

For peas, beans, or other ſimilar crops, it will obviouſly be neceſſary to have larger ſpaces between the rows, and greater diſtances in them, which muſt render a larger portion of ground capable of being planted in a given time. When the children engaged in performing the work of dropping the ſeed into the holes, are only able to drop into one hole, ſix are required to follow one dibbler; when capable of dropping into two holes, three are ſufficient for one dibbler; and where they can drop into three holes, two are only requiſite for a dibbler. The wages are various according to theſe circumſtances; for thoſe who perform in the firſt manner, it is generally three pence a-day for each child, in the ſecond it is ſeven pence, and in the third about ten pence halfpenny.

Four men to perform the buſineſs of dibbling, with a ſuitable number of

* Modern Agriculture, vol. III. p. 83. † Burroughes in Appendix to Norfolk Report.

‡ Young's Agricultural Report of Suffolk.

droppers, are conſidered as ſufficient to work in one party, which is a much better practice than that of allowing the whole to work together, as the ſeed is ſet with much greater regularity and exactneſs *.

The expence of performing the buſineſs of planting in this manner, is generally about nine or ten ſhillings an acre for wheat, eight for barley and oats †, and ſeven for peas or vetches †; but this muſt evidently be liable to conſiderable variation, according as the ſituation is populous, and the price of labour cheap, or the contrary.

In ſome of the dibbling diſtricts, the difficulty and expence of the hand method have been attempted to be leſſened by the uſe of machinery, ſuch as rollers of the drill and ſpiked kind. The manual practice is, however, to be preferred where labourers can be procured. This circumſtance of uſing implements for the purpoſe of putting in the corn, has probably led ſome to ſuppoſe that the practice of dibbling was more on the decline than is perhaps really the caſe.

The kinds of ſoil on which this method of putting in the ſeed has been practiſed with the moſt advantage, are the light and mixed ſandy, and thoſe of a loamy quality. On the deep ſtiff clays, it is ſeldom had recourſe to. The newly broken up lands of almoſt all deſcriptions may, in moſt caſes, be advantageouſly planted in this method.

Various ſorts of crops have been found capable, in particular ſituations and circumſtances, of being put into the ground in this way with advantage, ſuch as thoſe of wheat, barley, oats, peas, beans and vetches; the firſt is, however, the kind of crop for which it is the moſt commonly employed. Oats may, in many caſes, be beneficially dibbled on ſuch lands as have been newly ploughed up from leys. But it is ſuppoſed by ſome, that barley can ſeldom be dibbled, by reaſon the land is ſo dry in April that the holes will run in, and not ſtand open to receive the ſeed ‡.

In the more ſouthern parts of the kingdom, the moſt favourable ſeaſon for putting in wheat, in this mode, has been found to be the latter end of September, or the beginning of October; the months of March and April for barley and oat crops; and for peas and beans as early in the ſpring months as the nature of the ſeaſon will admit.

The quantity of ſeed that is required in this method of putting it into the ground, is conſiderably leſs than where the broadcaſt, or perhaps even the

* Baker in Norfolk Report. † Ibid. ‡ Young's Agricultural Report of Suffolk.

drill ſyſtem, is followed; but the ſavings muſt conſtantly depend, in a great degree, upon the ſteadineſs and accuracy of the perſons employed in dropping the ſeed, and the number of the ſeeds that are put into each hole. It has been ſuggeſted by an experienced cultivator in this way, that where the droppers are properly attended to, the ſaving in wheat may be about ſix pecks in the acre, in barley eight, and in peas and vetches about four *.

The number of grains that are depoſited in each hole, is different in different circumſtances, but the moſt general practice, and that which has been found the moſt ſucceſsful, is three or four for grain crops, and one or two for thoſe of peas, beans, and others of the ſame kind †. It is evident, however, that they ſhould neither be ſet too thickly, nor in too thin a manner: as in the former caſe the plants may be drawn up, and the crops in conſequence become weak and not productive; and in the latter, as where only one grain is placed in each hole, they may be ſo thin as to afford but a ſcanty produce from the want of plants. Where due care has been taken in the putting in of the ſeed, there is moſtly a conſiderable increaſe of produce in this way of ſowing over the others. The exact amount of the additional produce that is thus obtained, has not, however, been fully ſhewn by the experiments of intelligent cultivators; but it has been ſuppoſed, in reſpect to wheat, to be from four to ſix buſhels in the acre ‡, and the reſult of an experiment made with the view of aſcertaining the difference in the produce between ſowing and ſetting barley, proves it to be ſtill greater in that ſort of grain, the experimenter having had twelve buſhels on the acre more in the land that was dibbled, than that which was ſown §. Concluſions drawn from looſe eſtimates, or ſingle experiments, cannot, however, be depended upon, but it can ſcarcely be doubted that the quantity of produce is greater in the method of dibbling the ſeed than in ſowing it broadcaſt. In the quality of the grain there is likewiſe a ſuperiority: the wheat and barley produced in this way are ſaid to be not only more free from droſs, but larger in the kernel, and of courſe weighing conſiderably heavier ‖. It is eaſy to perceive, that when the ſeed is put into the ſoil in the regular and equal manner that is the caſe in ſetting with the hand when well performed, the crops, of whatever kind they may be, may have a ſuperiority in theſe different reſpects, both from the plants in ſuch inſtances being leſs crowded together, and their becoming in conſequence

* Baker in Appendix to Norfolk Report.
† Varlo in ditto.
‡ Burroughes in Norfolk Agricultural Report.
§ Baker in ditto.
‖ Ibid.

more ſtrong and vigorous, and from the air and ſun being more fully admitted, by which they become more equally, as well as more perfectly, ripened. It is probable too, that in ſuch caſes, from the greater regularity of the plants, the hoeing or after-culture of the crops, where it is practiſed, may be more effectually and more fully performed. There is alſo another reaſon, that in particular inſtances has been ſuggeſted as the cauſe of the quality of the grain, in this mode of ſowing, being ſuperior, which is that of wheat being frequently dibbled upon ſuch land as has been broken up from a new clover ley, in which caſe the ſeeds being ſet in the furrow ſlice, or flag, the plants are not liable to be obſtructed in their growth; whereas, when ſown in the uſual broadcaſt method, much of the ſeed muſt of courſe fall into crevices and openings between the furrow ſlices, where they muſt be greatly impeded in their vegetation by weeds and other cauſes *. This ſhows likewiſe the abſurdity of putting wheat crops in by the broadcaſt method upon ſuch preparations of land.

The practice of dibbling peas and beans is only met with in particular diſtricts to any great extent. In the county of Glouceſter, where it prevails in a conſiderable degree, the buſineſs is chiefly performed by women. In Middleſex and ſome other counties, both men and women are, however, employed in this ſort of field work. In executing this operation with crops of theſe kinds, it is the cuſtom in ſome places to form the rows acroſs the ridges, but in others, the lengthways of them. The latter method is probably the beſt, as the planters may be kept more perfectly diſtinct from each other, and the ſeed be put into the beſt part of the mold in the furrow ſlice, while in the former it muſt frequently be liable to be put into the looſe earth in the ſeams or interſtices formed by the furrow ſlices, and thus be provided with a leſs ſuitable bed for vegetating in. With ſome ſetters, it is likewiſe a practice to make uſe of a line in order to guide them in placing the rows at equal diſtances, but thoſe who have been much uſed to the buſineſs ſeldom find it neceſſary. In performing the work, the ſetters, beginning each at the end of a row, and forming holes at the diſtances of about two or three inches from each other, and of nearly the ſame depths, introduce one or two peas or beans into each hole; proceeding in the ſame manner until the whole is done. The intervals or diſtances between the rows are generally from about ten to fourteen or fifteen inches †.

The proportion of ſeed that is requiſite in this mode of ſowing muſt obviouſly

* Donaldſon's Modern Agriculture, vol. III. † Ibid.

be different according to the number of ſeeds put into each hole, and the differences in the width of the intervals; but from two and a half to three buſhels are the moſt uſual quantities. The expence of this ſort of labour is in moſt diſtricts from about three ſhillings and ſix pence to four ſhillings and ſix pence, or five ſhillings, the acre. After the ſeed has been ſet, the field is moſtly harrowed well over in order to cover it, by means of a light ſort of harrow.

This method of planting, beſides its employing a conſiderable number of poor perſons, the ſaving of ſeed, and the great improvement in the quantity as well as quality of the grain, poſſeſſes other advantages; the ſeed is depoſited to a proper depth in the beſt parts of the ſuperficial ſoil, and in ſuch a manner, where proper attention is paid, as that the greateſt poſſible benefits may be derived from the ſucceeding hoeings of the crops. And in the lighter ſorts of land the treading of the labourers in performing the buſineſs, by preſſing the looſe mold more into contact with the grain, may render it capable of vegetating in a more quick and perfect manner. From the ſeed in this way being placed more in the ſolid or firm parts of the ſoil, it may likewiſe be leſs expoſed to danger from worms, grubs, or other deſtructive animals of the ſame kind. And in many ſorts of grain, as well as peas and beans, the danger of their being brought to the ſurface by harrowing is obviated *. The ſtraw being ſtouter, the crops may be leſs liable to lodge after heavy rains, and leſs expoſed to the danger of mildews †.

It would ſeem obvious from what has been obſerved on the different methods of putting ſeed into the ground, that each of them may poſſeſs a degree of merit, and be uſeful in particular caſes and ſituations of ſoils and crops, but that in general the broadcaſt practice is probably liable to more objection than either that of drilling or dibbling, from its being leſs exact, and the ſeed being diſperſed with ſuch inequality, and in ſo irregular a manner, as to admit of little or no after-aſſiſtance being given to the crops during the period of their growth by hoeing or ſtirring of the more ſuperficial parts of the ſoil about the roots of the plants. It muſt, notwithſtanding, be had recourſe to probably in ſuch caſes and circumſtances as have been already noticed; but wherever it is practiſed, as hoeing is in a great meaſure excluded, the land ſhould obviouſly be in a good ſtate of tilth, and as free as poſſible from the production of weeds; points that have in general been inadequately attended to in this ſyſtem of arable management.

* Experienced Farmer, vol. I.

† Norfolk Agricultural Report, p. 211.

The method, by means of implements of the drill kind, in ſituations, and under circumſtances of ſoil and preparation, where it is capable of being properly had recourſe to, both from the ſeed being depoſited with more exactneſs in reſpect to the depths and the regularity of the rows, as well as from the ſuperior ſtate of tilth that is requiſite in the firſt inſtance, and its eaſily admitting of every kind of culture while the crops are growing, is certainly not only more perfect, but probably better calculated for the affording of full crops, and more adapted to the keeping of the land in the moſt advantageous condition for improved modes of cropping.

And the mode of ſetting or putting the ſeed into the ſoil by the hand, though probably leſs exact than that by the drill machine, except where particularly attended to, and certainly leſs capable of being beneficially employed from the greater expence which it incurs, may, notwithſtanding, as it admits of after-culture, be found an uſeful practice in ſome caſes, eſpecially where the land has been broken up from clover, or any new ley, and is not too ſtiff or adheſive *. It has, however, been ſuggeſted †, that the method of ſowing in drills is to be preferred, from the circumſtance of a greater quantity of earth or mold being turned over, and conſequently air included in larger proportions in the interſtices, as in dibbling the ſides of the holes are rendered more ſolid, and thereby leſs proper for the reception of the tender roots of the young plants.

But the ſuperiority or advantage of any particular method of ſowing or putting crops into the ground, over that of others, will probably be ſhewn in the moſt clear and ſatisfactory manner by the comparative ſtatements that have been given by thoſe attentive cultivators who have inſtituted and conducted experiments on different kinds of ſoils and crops, with the view of aſcertaining a matter of ſo much importance to huſbandry.

In experiments made on two acres of a ſtiff hazel-coloured loamy ſoil, laid up in eleven-feet ridges, worth about twenty ſhillings an acre, and ſown with oats, cole ſeed, barley, beans, and wheat, in the drill and broadcaſt methods alternately, in the rotation of firſt oats, ſecond cole, third barley, fourth beans, and fifth wheat, the ſuperiority of the drill ſyſtem, over that of the broadcaſt, was found by Mr. Amos to be conſiderable, not leſs than from one pound to

* Experienced Farmer, vol. I.

† Darwin's Phytologia, p. 441.

one pound fourteen ſhillings the acre in the grain and pulſe crops, and one ſhilling and ſixpence in that of the cole *.

* The reſult of theſe experiments is given in the following manner:

CROPS.

OATS.

Drilled Acre.	DR. £.	s.	d.	*Broadcaſt Acre.*	DR. £.	s.	d.
1783.				1783.			
March 6, Ploughing up from ſwarth	0	5	0	March 6, Ploughing up from ſwarth	0	5	0
10, Five harrowings and one rolling . . .	0	3	0	10, Eight harrowings .	0	4	0
Drilling two inches deep, and eight aſunder .	0	0	6	Seed ſixteen pecks, at 9d.	0	12	0
Harrowing after .	0	0	6	Sowing . . .	0	0	3
Twelve pecks ſeed, at 9d.	0	9	0	April 20, Rolling . . .	0	0	6
April 20, Rolling . . .	0	0	6	May 24, Hand-weeding, firſt time	0	2	6
May 14, Breaſt hoeing, firſt time	0	2	0	June 15, Ditto, ſecond time .	0	3	0
June 5, Ditto, ſecond time .	0	2	0	Rent, &c. . .	1	1	0
Hand-hoeing . .	0	1	6		£. 2	8	3
Rent, &c. for one year	1	1	0				
	£. 2	5	0				

Contra.	CR. £.	s.	d.	*Contra.*	CR. £.	s.	d.
Sept. 19, Crop, fifty-ſix buſhels, at 2s. 3d. . . .	6	6	0	Sept. 19, Crop, fifty buſhels, at 2s. 1½d. . . .	5	6	3
Profit .	£. 4	1	0	Profit .	2	18	0
				Superiority of the drill crop . .	1	3	0
					£. 4	1	0

COLE-SEED.

Drilled Acre.	DR. £.	s.	d.	*Broadcaſt Acre.*	DR. £.	s.	d.
1783.				1784.			
Nov: 4, Ploughing land acroſs five inches deep . .	0	5	0	Four ploughings . .	0	18	0
1784.				Six harrowings . .	0	3	0
March 1, Break-harrowing, firſt time	0	1	6	Two rollings . .	0	1	0
26, Ploughing, ſecond time	0	5	0	Lime . . .	1	0	0
April 24, Break-harrowing, ſecond time . . .	0	1	0	June 28, Sowing every other land, ſeed, harrowing, &c.	0	1	0
				Rolling . . .	0	0	6
Carried forward .	£. 0	12	6	Carried forward .	£. 2	3	6

And on two acres of land ridged in the ſame way, but the ſoil of which was a light ſandy loam, worth about eighteen ſhillings the acre, ſown in the

	£.	s.	d.
Brought forward,	0	12	6
Harrowing and rolling	0	1	0
May 16, Ploughing land, third time	0	4	0
30, Lime, 4½ chaldrons charged	1	0	0
Drag harrowing . .	0	1	6
June 12, Rolling and harrowing	0	1	6
28, Ploughing, fourth time	0	4	0
Harrowing, and rolling twice . . .	0	2	0
29, Drilling every other land one inch deep and twelve aſunder .	0	0	6
Seed, a quarter peck .	0	0	6
Harrowing . .	0	0	6
July 24, Breaſt-hoeing, firſt time	0	2	6
Aug. 16, Ditto, ſecond time .	0	2	0
Rent, &c. one year .	1	1	0
Expences .	£. 3	13	6

Contra.			CR.
Nov. 24, Value of crop appraiſed	4	0	0
Profit .	£. 0	6	6

	£.	s.	d.
Brought forward,	2	3	6
July 10, Harrowing . .	0	0	6
18, Hoeing, firſt time .	0	3	0
Aug. 12, Ditto, ſecond time .	0	2	6
Rent, &c. one year .	1	1	0
Expences .	£. 3	10	6

Contra.			CR.
Nov. 24, Value of crop appraiſed	3	16	0
Profit .	0	5	6
Superiority of drilled crop .	0	1	0
	£. 0	6	6

BARLEY.

Drilled Acre.			DR.
1784.	£.	s.	d.
Dec. 24, To ploughing, firſt time	0	5	0
1785.			
Lime, charged half .	0	18	0
March 20, Break-harrowing, .	0	1	0
April 1, Ploughing, ſecond time	0	4	0
Harrowing, three times and rolling . . .	0	2	0
Drilling ſeed, two inches by nine . . .	0	0	6
Harrowing ditto .	0	0	6
Seed, eight pecks, at 9d.	0	6	0
Carried forward .	£. 1	17	0

Broadcaſt Acre.			DR.
1784.	£.	s.	d.
Dec. 24, Ploughing, firſt time .	0	5	0
1785.			
April 1, Ploughing, ſecond time	0	4	0
Seed, twelve pecks, at 9d. and ſowing . .	0	12	3
May 20, Lime, half charged .	0	18	0
Break-harrowing .	0	1	0
Harrowing four times	0	2	0
Rolling . . .	0	0	6
Carried forward .	£. 2	2	9

drill and broadcaſt manner with turnips, barley, clover, and wheat, in the rotation of firſt turnips, ſecond barley, third red clover, fourth wheat; the trials

		£.	s.	d.
	Brought forward,	1	17	0
	Rolling . . .	0	0	6
May 10,	Breaſt-hoeing, firſt time	0	2	0
	Hand-weeding rows .	0	1	0
June 4,	Breaſt-hoeing, ſecond time	0	1	6
	Hand-weeding rows .	0	1	0
	Rent, &c. one year .	1	1	0
	Expences .	£. 3	4	0

Contra. CR.

Aug. 20,	Crop reaped, and in a few days thraſhed, produce 58 buſhels, at 3s. .	8	14	0
	Profit .	£. 5	10	0

		£.	s.	d.
	Brought forward,	2	2	9
	Hand-hoeing firſt time	0	2	6
	Hand-weeding . .	0	2	0
	Rent, &c. one year .	1	1	0
	Expences .	£. 3	8	3

Contra. CR.

Aug. 26,	Crop reaped, and in a few days thraſhed, produce 51 buſhels, at 3s .	7	13	0
	Profit .	4	4	9
	Gain by the drilled crop	1	5	3
		£. 5	10	0

BEANS.

Drillea Acre. DR.

1785.		£.	s.	d.
Nov. 4,	Ploughing, firſt time .	0	5	0
1786.				
March 6,	Break-harrowing .	0	1	0
8,	Ploughing, ſecond time	0	4	0
	Four harrowings at 6d	0	2	0
	Rolling . . .	0	0	6
	Drilling the ſeed three by 24 inches . .	0	0	6
	Harrowing ditto .	0	0	6
	Seed, for 8 pecks, at 10½d.	0	7	0
April 20,	Rolling . . .	0	0	6
	Harrowing . .	0	0	6
May 16,	Horſe-hoeing, firſt time	0	1	0
20,	Hand-hoeing the rows	0	1	6
June 16,	Horſe-hoeing the intervals, ſecond time .	0	1	6
18,	Hand-hoeing the rows	1	1	0
26,	Earthing up ditto, firſt time . . .	0	1	0
	Carried forward .	£. 1	7	6

Broadcaſt Acre. DR.

1785.		£.	s.	d.
Nov. 4,	Ploughing, firſt time .	0	5	0
1786.				
March 4,	Break-harrowing .	0	1	0
8,	Ploughing, ſecond time	0	4	0
	Sowing the ſeed .	0	0	3
	Harrowing ditto, 5 times	0	2	6
	Seed, twelve pecks at 10½d.	0	10	6
April 20,	Rolling and harrowing .	0	1	0
May 29,	Hand-weeding, firſt time	0	3	0
June 30,	Ditto, ſecond time .	0	1	6
	Rent, &c. . .	1	1	0
	Expences .	£. 2	9	9

Contra. DR.

Sept. 29,	Produce, thirty buſhels	5	5	0
	Profit .	2	15	3
	Gain by the drilled .	1	1	3
		£. 3	16	6

of the ſame cultivator alſo turned out in favour of the drill method. The advantage in the turnip and clover crops being from eight to ten ſhillings and

Drilled Acre continued.

	£.	s.	d.			£.	s.	d.
Brought forward,	1	7	6	*Contra.*				CR.
July 10, Earthing up ditto, ſecond				1786.				
time . . .	0	1	0	Sept. 29, Produce, thirty-ſix buſhels,				
Rent, &c. . .	1	1	0	at 3s. 6d. . .		6	6	0
Expences .	£. 2	9	6	Profit .	£.	3	16	6

WHEAT.

Drilled Acre. DR.

1786.	£.	s.	d.
Sept. 8, Ploughing, firſt time .	0	5	0
Oct. 6, Break-harrowing and weeding . . .	0	3	0
8, Second ploughing .	0	4	0
Harrowing thrice, rolling once . . .	0	2	0
Drilling every other land, and 1-third by 1-eighth	0	0	6
1787.			
Seed, ſeven pecks, harrowing 6d . .	0	9	10
April 20, Rolling and harrowing for weeding . .	0	1	0
May 6, Firſt hoeing intervals, and hand-weeding the rows	0	3	0
30, Second hoeing . .	0	1	6
June 4, Hand-weeding rows .	0	1	0
Year's rent, &c. . .	1	1	0
Expences .	£. 2	11	10

Contra. CR.

1787.			
Aug. 24. Produce, 36 buſhels .	9	18	0
Profit .	£. 7	6	2

Broadcaſt Acre. DR.

1786.	£.	s.	d.
Sept. 28, Ploughing, firſt time .	0	5	0
Oct. 6, Break-harrowing .	0	1	0
Gathering weeds .	0	2	0
8, Ploughing, ſecond time	0	4	0
Seed, nine pecks, 1s. 4d.	0	12	0
Sowing ditto . .	0	0	3
1787. Harrowing five times .	0	2	6
April 20, Rolling and harrowing, &c.	0	1	0
May 14, Hand-weeding, firſt time	0	2	6
June 12, Hand-weeding, ſecond time,	0	2	0
Rent, &c. one year .	1	1	0
Expences . £.	2	13	3

Contra. CR.

1787.			
Aug. 26, Produce, 30 buſhels .	8	5	0
Profit . £.	5	11	9
Gain by the drilled acre	1	14	5
£.	7	6	2

ſixpence, and in thoſe of the grain kinds, from ſeventeen ſhillings to one pound nine ſhillings *.

* CROPS.

1ſt. TURNIPS.

Drilled Acre.		DR.		
1789.		£.	s.	d.
Feb. 11,	Ploughing, firſt time .	0	5	0
Mar. 31,	Break-harrowing .	0	1	0
April 28,	Ploughing, ſecond time	0	4	6
May 10,	Harrowing twice .	0	1	0
	Gathering couch .	0	2	6
24,	Ten loads of rotten dung, half charged . .	0	12	6
	Ploughing, third time .	0	4	0
	Rolling . . .	0	0	6
June 16,	Harrowing twice .	0	1	0
	Rolling . . .	0	0	6
18,	Ploughing, fourth time	0	4	0
	Harrowing thrice .	0	1	6
	Rolling . . .	0	0	6
	Drilling ſeed one inch by twelve . . .	0	0	6
	Harrowing ditto .	0	0	6
	Seed, 1lb. ſugar-loaf .	0	0	6
July 20,	Harrowing, firſt weeding	0	0	6
28,	Breaſt-hoeing, ſecond ditto	0	2	0
Aug. 18,	Hand ditto, third ditto	0	2	6
	Rent, one year, &c.	0	19	0
	Expences .	£. 3	4	0

Contra.	CR.		
Dec. 10, Crop appraiſed . .	3	15	6
Profit .	£. 0	11	6

Broadcaſt Acre.				
1789.		£.	s.	d.
Mar. 1,	Ploughing, firſt time .	0	5	0
31,	Break-harrowing .	0	1	0
April 28,	Ploughing, ſecond time	0	4	6
May 10,	Harrowing twice .	0	1	0
	Gathering couch .	0	2	6
24,	Ten loads of dung, half charged . . .	0	12	6
	Ploughing in ditto .	0	4	0
	Rolling . . .	0	0	6
June 16,	Harrowing and rolling	0	1	0
18,	Ploughing, fourth time	0	4	0
	Three harrowings and one rolling . . .	0	2	0
	Seed, 1lb. ſugar-loaf .	0	0	6
	Sowing ditto . .	0	0	3
	Harrowing and rolling ditto . . .	0	1	0
July 20,	Harrowing for the firſt weeding . . .	0	0	6
28,	Hand-hoeing, firſt time	0	3	6
Aug. 18,	Ditto, ſecond time .	0	2	6
	Rent, one year, &c. .	0	19	0
	Expences .	£. 3	5	3

Contra.	CR.		
Dec. 12, Crop appraiſed . .	3	8	0
Profit . .	0	2	9
Gain by drill . .	0	8	9
	£. 0	11	6

2d. BARLEY.

On land where the ſoil was a light ſandy loam, of the value of about twenty ſhillings the acre, managed in the method that has been juſt deſcribed, the

2d. BARLEY.

Drilled Acre.	DR. £.	s.	d.	*Broadcaſt Acre.*	DR. £.	s.	d.
1789.				1789.			
Charge of dung, half .	0	12	6	Half the charge of the dung . . .	0	12	0
Dec. 20, Ploughing, firſt time .	0	5	0	Nov. 20, Ploughing, firſt time .	0	4	6
1790.				1790.			
Mar. 24, Break-harrowing .	0	1	0	Mar. 24, Break-harrowing .	0	1	0
April 10, Ploughing, ſecond time	0	4	0	April 10, Ploughing, ſecond time	0	4	0
Harrowing thrice .	0	1	6	Seed, twelve pecks, at 10d.	0	10	0
Rolling . . .	0	0	6	Sowing ditto . .	0	0	6
Drilling the ſeed two inches by nine . . .	0	0	6	Harrowing ditto, four times	0	2	0
Harrowing and rolling ditto	0	1	0	Rolling ditto . .	0	0	6
Seed, eight pecks, at 10d.	0	6	8	May 20, Weeding the firſt time	0	3	0
May 6, Hoeing, firſt time .	0	2	8	June 16, Weeding, ſecond time	0	2	0
Hand-weeding rows .	0	1	0	One year's rent, &c. .	0	19	0
June 16, Hoeing, ſecond time .	0	1	6	Expences .	£. 2	18	6
Hand-weeding rows .	0	1	0				
Rent, &c. one year .	0	19	0	*Contra.*	CR.		
Expences .	£. 2	17	2	Produce, forty-ſeven buſhels	8	4	6
Contra	CR.			Profit .	5	6	0
1790.				In favour of the drilled crop . . .	0	17	10
Aug. 26, Produce, fifty-two buſhels	9	1	0		£. 6	3	10
Profit .	£. 6	3	10				

3d. RED CLOVER.

Drilled Acre.	DR. £.	s.	d.	*Broadcaſt Acre.*	DR. £.	s.	d.
1791.				1791.			
Seed, one ſtone, laſt year	0	7	0	One ſtone of ſeed .	0	7	0
Mar. 29, Buſh-harrowing 1s. raking and gathering off weeds, 3s. 6d. rolling 6d. .	0	5	0	Mar. 30, Buſh-harrowing .	0	1	0
				Raking and gathering weeds . . .	0	3	0
June 30, Mowing and making firſt crop . . .	0	5	0	Rolling . . .	0	0	6
Carting home . .	0	15	0	Mowing the firſt crop	0	2	6
Expences on ſecond crop	0	15	6	Making it into hay .	0	2	6
Year's rent, &c. .	0	19	0	Leading ditto home .	0	12	0
Expences .	£. 3	6	6	Mowing the ſecond crop	0	2	0
				Carried forward .	£. 1	10	6

crops being potatoes, barley, red clover, and wheat, in the courſe of firſt potatoes, ſecond barley, third clover, fourth wheat, the ſuperiority of the drill

Contra. CR.

	£.	s.	d.
Firſt eddiſh . .	0	4	0
Firſt crop, two ton hay	6	0	0
Second ditto, one and a half ton . .	4	10	0
Second eddiſh . .	0	5	0
	10	19	0
Expences .	3	6	6
Profit . .	£. 7	12	6

4th. WHEAT.

Drilled Acre. DR.

1791.	£.	s.	d.
Oct. 4, Ploughing . .	0	5	0
Five harrowings and one rolling . .	0	3	0
Drilling ſeed $2\frac{1}{2}$ inches by nine . . .	0	0	6
Harrowing ditto .	0	0	6
Seed, 8 pecks, at 1s. 6d.	0	12	0
1792.			
April 16, Harrowing and rolling, firſt weeding . .	0	1	0
May 1, Hoeing the firſt time	0	2	0
12, Hand-weeding rows .	0	1	6
20, Hoeing ſecond time .	0	1	6
24, Hand-weeding rows .	0	1	0
Rent one year, &c. .	0	19	0
Expences .	£. 2	7	0

Contra. CR.

1792.			
Aug. 30, Produce, forty-two buſhels	10	10	0
Sheep feed April .	0	3	6
	10	13	6
Profit .	£. 8	6	6

Broadcaſt Acre. DR.

1791.	£.	s.	d.
Oct. 4, Ploughing . . .	0	5	0
Seed nine pecks, 1s. 6d.	0	13	6
Sowing ditto . .	0	0	3
Harrowing ſix times .	0	3	0
1792.			
April 16, Ditto and rolling .	0	1	0
May 12, Weeding firſt time .	0	3	0
26, Ditto ſecond ditto .	0	2	0
Rent one year, &c. .	0	19	0
Expences .	£. 2	6	9

Contra. CR.

	£.	s.	d.
Sheep feed . .	0	3	6
Produce, thirty-ſix buſhels	9	0	0
	9	3	6
Profit .	6	16	9
In favour of drilled .	1	9	9
	£. 8	6	6

Contra. CR.

	£.	s.	d.
Brought forward,	1	10	6
Making ditto . .	0	2	6
Leading ditto home .	0	9	0
One year's rent, &c. .	0	19	0
Expences .	£. 3	1	0

Contra. CR.

Firſt and ſecond eddiſhes,	0	8	0
Ditto crops, $3\frac{1}{4}$ tons .	9	15	0
	10	3	0
Expences .	3	1	0
Profit . .	7	2	0
In favour of drilled	0	10	6
	£. 7	12	6

practice appears ſtill more evident. As the detail of the potatoe crop ſeems principally intended to ſhew the difference between horſe and hand hoeing, it is here omitted *.

CROPS.

1ſt. POTATOES.

Drilled Acre.
Details of omitted.

Broadcaſt Acre.
Details of omitted.

2d. BARLEY.

Drilled Acre.		DR.		
1790.		£.	s.	d.
	Charge of dung half .	0	15	0
Jan. 18,	Ploughing, firſt time .	0	5	0
Mar. 9,	Break-harrowing .	0	1	0
April 10,	Ploughing, ſecond time	0	4	0
	Three harrowings .	0	1	6
	Rolling . . .	0	0	6
	Drilling ſeed 2 by 9 inches	0	0	6
	Harrowing and rolling do.	0	1	0
	Seed, ſeven pecks, at 12d.	0	6	5
May 14,	Hoeing the firſt time .	0	2	0
	Hand-weeding rows .	0	1	0
June 6,	Hoeing ſecond time .	0	2	0
	Hand-weeding rows .	0	0	6
	Rent one year, &c. .	1	1	0
	Expences .	£. 3	1	5
Contra.		CR.		
Sept. 4,	Produce, 56 buſhels 3s. 6d.	9	16	0
	Profit .	£. 6	14	7

Broadcaſt Acre.		DR.		
1790.		£.	s.	d.
	Charge of dung half .	0	15	0
Jan. 18,	Ploughing, firſt time .	0	5	0
Mar. 9,	Break-harrowing .	0	1	0
April 10,	Ploughing, ſecond time	0	4	0
	Seed, twelve pecks, at 10d.	0	10	0
	Sowing ditto .	0	0	3
	Harrowing ditto four times	0	2	0
	Rolling . . .	0	0	6
May 14,	Weeding firſt time .	0	4	0
June 4,	Ditto ſecond time .	0	1	6
	Rent one year . .	1	1	0
	Expences .	£. 3	4	3
Contra.		CR.		
Sept. 6,	Produce, forty-nine buſhels, 3s. 4d. . . .	8	3	4
		4	19	1
	In favour of drilled acre	1	15	6
		£. 6	15	7

3d. CLOVER.

Drilled Acre.		DR.		
1791.		£.	s.	d.
	Seed, one ſtone ſown laſt year . . .	0	7	0
Mar. 30.	Buſh-harrowing . .	0	1	6
	Raking and gathering weeds	0	2	6
	Rolling . . .	0	0	6
	Carried forward .	£. 0	11	6

Broadcaſt Acre.		DR.		
1791.		£.	s.	d.
	One ſtone ſeed . .	0	7	0
Mar. 30,	Buſh-harrowing .	0	1	6
	Raking and gathering weeds	0	2	6
	Rolling . . .	0	0	6
	Carried forward .	£. 0	11	6

The value of the ſtraw in all theſe experiments is ſuppoſed to be adequate to the expences incurred in reaping, threſhing, and conveying the produce to the markets.

It is likewiſe aſſerted, that in a variety of trials conducted in a ſimilar manner, but on lands of very inferior qualities, as ſuch as were not worth more than from twelve to fourteen ſhillings the acre a-year, the advantages were

	£.	s.	d.
Brought forward	0	11	6
July 4, Mowing firſt crop .	0	2	6
Making . . .	0	2	6
Carting home, &c. .	0	12	0
Mowing ſecond crop .	0	2	0
Making ditto . .	0	2	6
Carting ditto home, &c.	0	9	0
Rent one year, &c.	1	1	0
Expences .	£. 3	3	0

Contra. CR.

Produce of the two crops, three tons . .	9	0	0
Firſt and ſecond eddiſh	0	10	0
	9	10	0
Expences .	3	3	0
Profit .	£. 6	7	0

	£.	s.	d.
Brought forward	0	11	6
June 20, Mowing firſt crop .	0	2	6
Making it . . .	0	2	6
Leading ditto . .	0	10	6
Mowing ſecond crop .	0	2	0
Making ditto . .	0	3	0
Leading ditto . .	0	7	6
Rent one year, &c. .	1	1	0
Expences .	£. 3	0	6

Contra. CR.

Produce, two tons and a half, eddiſh 9s. .	8	14	0
Profit .	5	13	6
In favour of the drilled	0	13	6
	£. 6	7	0

4th. WHEAT.

Drilled Acre. DR.

1791.	£.	s.	d.
Oct. 1, Ploughing land . .	0	5	0
Four harrowings and one rolling . . .	0	2	6
Drilling ſeed 2½ by 9 inches	0	0	6
Harrowing ditto . .	0	0	6
1792.			
Seed, eight pecks, at 1s. 6d.	0	12	0
April 17, Harrowing and rolling firſt time . . .	0	1	0
28, Hoeing firſt time .	0	2	0
May 2, Hand-weeding rows .	0	1	6
Carried forward, £.	1	5	0

Broadcaſt Acre. DR.

1791.	£.	s.	d.
Oct. 4, Ploughing land . .	0	5	0
Seed, eight pecks, 1s. 6d.	0	12	0
Sowing ditto . .	0	0	6
Harrowing ditto ſix times	0	3	0
1792.			
April 19, Ditto and rolling firſt time . . .	0	1	0
May 14, Weeding firſt time .	0	3	0
28, Ditto ſecond ditto .	0	2	0
Rent one year, &c. .	1	1	0
Expences .	£. 2	7	6

Contra.

never upon an average leſs than from twelve to fourteen ſhillings the acre annually in favour of the drill practice *.

The advantage of the drill method of ſowing even for grain crops, ſeems therefore to be placed by theſe experiments in a point of view that muſt tend to promote the practice; and for peaſe, beans, turnips, potatoes, cabbages, vetches, and many ſimilar crops, it has long been almoſt generally conſidered as the moſt convenient and beneficial by thoſe who have not ſuppoſed it adapted to grain.

But in reſpect to an increaſe in the produce on various deſcriptions of ſoil, ſuch as thoſe of the loamy and mellow, as well as the cold, clayey, and more ſtiff kinds, experiments which are aſſerted to have been made with much accuracy appear likewiſe from Mr. Cook's ſtatements to be in favour of the drill ſyſtem †. This was found to be the caſe in Mr. Boote's practice, when extended

	£.	s.	d.
Brought forward	1	5	0
16, Hoeing the ſecond time	0	1	0
20, Hand-weeding rows .	0	1	0
Rent one year, &c. .	1	1	0
Expences .	£. 2	8	6

Contra. CR.

Sept. 14, Produce, thirty-ſix buſhels,			
6s. . . .	10	16	0
Sheep feeding April .	0	3	0
Profit .	£. 8	10	6

Contra. CR.

Sept. 18. Produce, for thirty buſhels,	£.	s.	d.
6s. . . .	9	0	0
Sheep feeding April .	0	3	0
Profit .	£. 6	15	6
Gain in favour of drilled acre . . .	1	15	0
	£. 8	11	6

* Amos on Drill Huſbandry, p. 126.

† The reſults are the following:

WHEAT.

Drilled produce per acre.	B.	G.	Q.	*Broadcaſted* produce per acre.	B.	G.	Q.
1786. On loamy ſoils - -	47	0	0				
Cold clay ditto - -	44	5	2	On adjoining land - - -	9	4	2
Ditto - - - -	25	1	3				

BARLEY.

On light land - - -	72	4	0				
Very light ſandy land	44	0	0	On ſame ſort of land - - -	37	0	4

to more than three hundred and ſixty acres, as well as in that of many other cultivators *. Since the reſults of theſe trials were taken, the various improvements that have been made both in the machinery for the purpoſe of drilling the crops, and thoſe for hoeing and keeping them clean afterwards, muſt probably have contributed to render the differences in the quantities of produce under the different methods of ſowing ſtill more conſiderable.

The practical ſtatements of a later experienced drill cultivator may, probably, on theſe accounts, be more ſatisfactory, and afford a more correct view of the ſuperiority of the practice. The writer, after a ſlight trial with another drill machine, and becoming more acquainted with the nature of the drill culture from a more extenſive obſervation of it in different places, determined upon making uſe of Mr. Cook's machine, and the method of management which he has recommended. He began by drilling in November, 1791, two acres and a half of light, dry, loamy, land, not worth more than twelve ſhillings the acre, middling barley ſoil, broken up from the ſtate of a foul, poor, pea ſtubble, with red lammas wheat, at the rate of one buſhel to the acre, in rows with nine-inch intervals; another part of the field, confeſſedly better by five or ſix ſhillings the acre, being ſown at the rate of two buſhels to the acre in the broadcaſt method, and managed in the beſt manner of that practice. The crop of the broadcaſt ſowing was, on account of the thinneſs of that of the drilled, it is ſaid, much ſuperior in its appearance during the winter and the early part of ſpring; but the other after being ſcarified once in March, and horſe-hoed the laſt week in May, exhibited a decided ſuperiority, the broadcaſt declining conſiderably; and that on the crops being reaped, that part under the drill

WHEAT.

Drilled produce per acre.	B.	G.	Q.	*Broadcaſted* produce per acre.	B.	G.	Q.
1787. On flinty loam in clover ley one earth - -	25	1	0	On ſame ſort of land - -	20	3	0
Ditto two years clover ley - - -	27	2	0	On ſame ſort of land - -	25	0	0
Poor cold clayey after clover - - -	25	4	0	On ſame land adjoining - -	13	7	0

BARLEY.

On flinty loam after wheat	27	0	0	On the ſame land - - -	22	0	0

The ſame ſuperiority in the quantity of produce is evident in various other ſtatements, both with regard to wheat, barley, oats, beans, and peas; but the nature of the ſoil is either not diſtinctly mentioned, or there is not a clear compariſon made between the two methods of putting in the crops.

* Rev. Mr. Cook, in Memoirs of Bath Agricultural Society, vol. IV. p. 326.

ſyſtem afforded nineteen buſhels three pecks on the acre; while the part managed in the broadcaſt method did not produce quite five buſhels on the ſame extent of land.

And in a ſecond experiment on one acre of *potatoe fallow*, of the annual value of about twenty ſhillings, prepared by being once ploughed and harrowed, and ſown in March in the drill mode, with one buſhel of white lammas wheat; the plants when in double leaf being once ſcarified, and immediately afterwards harrowed acroſs with a common harrow, and after attaining the height of ſix or eight inches horſe-hoed, the crop had alſo the appearance of being thin and ſlight till after midſummer; but the produce, on being reaped, both in grain and ſtraw, was, notwithſtanding, very conſiderable, being twenty-nine buſhes three pecks, nine-gallon meaſure.

In the ſpring of the ſame year, thirty acres of land of the value of from thirty-five to forty ſhillings the acre, were tilled, manured, and prepared in every way in a ſimilar manner; fifteen acres of which being drilled in rows at nine inches, with two buſhels of ſeed to the acre, and fifteen acres broadcaſted, with from three to four buſhels the acre. During the growth of the crop, and at the time of cutting it, the ſeaſon was extremely wet. The crop put in, in the latter method, was lodged, ſtained, and ſecured with great difficulty; while that in the former was ſcarcely lodged at all, and being clear from weeds was houſed without injury, at half the extra expence of the other. The produce of grain was from ten to fifteen buſhels the acre more in quantity and one ſhilling the buſhel better in quality, although the broadcaſt crop had the advantage of being the firſt ſown, which was a point upon which much depended that ſeaſon.

And in a concluding experiment, a field of ten acres tilled, manured, and prepared for wheat, in every reſpect in a ſimilar manner, except that half was drilled with one half the above proportion of ſeed at nine-inch intervals, and the other ſown broadcaſt, doubts being entertained of the value of the land in different parts, two twelve-furrow ridges were, by way of proof, gathered through the middle of the part intended for drilling, the row ſowing being commenced on each ſide of them. The two ridges were managed, both in reſpect to ploughing, ſowing, and being weeded, in the manner of the common huſbandry of the diſtrict. The drilled crop had one ſcarifying and horſe-hoeing. At the period of harveſt, the two ridges were firſt cut; and immediately afterwards a breadth equal to one of them, of the drilled, was cut on each ſide, and each part ſecured and kept ſeparate till in a proper condition to be thraſhed, when they were carted into different barns, thraſhed out and winnowed; the drilled crop affording twenty nine buſhels three pecks, and the

broadcaſt twenty buſhels one peck. And that the experiment might be conducted with as much accuracy as poſſible, the ſame perſon was employed to winnow and meaſure the whole *.

Theſe experiments appear to have been made with ſo much exactneſs, and in ſo judicious a manner, that there can be little doubt of the reſults; and they have preſented ſo favourable an idea of the practice to the writer, that he aſſures us he has ever ſince followed it for the whole of his crops, repeatedly ſowing a part broadcaſt by way of proof; but that he has never once among all his trials ſeen the broadcaſt ſowing equal the drilled part.

There is another point in which the ſuperiority of the drill method of ſowing is ſaid to have a conſiderable ſuperiority, which is in the ſaving of ſeed; but it is probable that in this way the advantages cannot, in general, be ſo great as the ſtatements of cultivators under particular circumſtances of ſoil and ſituation have made them †. This would ſeem to be the caſe, from the obſervation

* Exter in Memoirs of the Bath Agricultural Society, vol IX. p. 23.

† The Rev. H. J. Cloſe ſtates the differences in expence, thus:

SEED-CORN.—*Expence on* 131 *Acres of Arable Land, in improved Drill-Huſbandry.*

	Acres.		£.	s.	d.
1799.	31	of Wheat, 3 pecks of ſeed per acre, at 8s. per buſhel	8	2	9
	26	Early white peas, 3 pecks per acre, at 8s. per buſhel	7	16	0
	18	Dun peas, 1 buſhel per acre, at 5s. 3d. per buſhel	4	14	6
	15	Tick beans, 3 pecks per acre, at 5s. per buſhel	2	16	3
	6	Early maz. beans, 3 pecks per acre, at 6s. per buſhel	1	7	0
	12	Oats, 1 buſhel per acre, at 3s. per buſhel	1	16	0
	13	Barley, 1 buſhel per acre, at 3s. 6d. per buſhel	2	5	6
	12	Vetches, 1½ buſhel per acre, at 6s. per buſhel	5	8	0
		Total	£. 34	6	0

SEED-CORN.—*Expence on* 131 *Acres of Land, in Broadcaſt-Huſbandry.*

	Acres.		£.	s.	d.
1799.	31	Of wheat, 3 buſhels per acre, at 7s. per buſhel	32	11	0
	26	Early peas, 4 buſhels per acre, at 8s. per buſhel	41	12	0
	18	Dun peas, 4 buſhels per acre, at 5s. 3d. per buſhel	18	18	0
	15	Tick beans, 3 buſhels of ſeed per acre, at 5s. per buſhel	11	5	0
	6	Early maz. beans, 3 buſhels per acre, at 6s. per buſhel	5	8	0
	12	Oats, 4 buſhels per acre, at 3s. per buſhel	7	4	0
	13	Barley, 3 buſhels per acre, at 3s. 6d. per buſhel	6	16	6
	12	Vetches, 3 buſhels per acre, at 6s. per buſhel	10	16	0
		Total	£. 134	10	6

Seed

ſo frequently made that thoſe engaged in this method of practice generally continue to increaſe the quantity of ſeed in almoſt all deſcriptions of crops, and on moſt ſorts of ſoil *. The great differences in the details of expence under the different methods, as given by the very intelligent practical agricultor juſt mentioned, ſhew, however, that much advantage may be derived in this way, where a correct attention is beſtowed in the management. On the exactneſs of this it is probable, however, that much of ſuch ſavings muſt depend.

There is reaſon to ſuppoſe that ſome proportions of ſeed may be more advantageous than others in regard to the quantity of produce, as it is obvious that injury muſt be ſuſtained from crops being either too thin, or too much crowded together upon the ground. Few experiments have hitherto, indeed, been made with a view to the aſcertaining of this matter †; but the reſults of the few trials that have been attempted, ſeem to ſpeak in favour of the drill method of only a middling proportion ‡.

	£.	s.	d.
Seed in the broadcaſt huſbandry	134	10	6
In the drill huſbandry	34	6	0
Saving in the ſeed-corn	£. 100	4	6

This it is added is the exact amount of the quantity of ſeed uſed on 131 acres of arable land the ſame year, and of the proportion of ſeed other farmers would have employed on the ſame quantity of land. The ſavings in this mode might, he thinks, be about 8,000,000 buſhels of wheat, 3,000,000 buſhels of barley, 1,000,000 buſhels of rye, 4,000,000 buſhels of oats, and 1,000,000 buſhels of beans and peas, which are yearly thrown away in ſeed-corn, independent of the additional produce which by the new ſyſtem might be obtained.—Theſe calculations cannot, it is obſerved, be ſuppoſed to be accurate, but the writer hopes the aggregate would not be very erroneous.

* Young's Annals of Agriculture.

† In Mr. Boote's experiments made in 1787, by drilling different grain crops, the reſults were, according to Mr. Cook, the following, on different ſorts of ſoil:

Quantity of Seed.	*Crop.*	*Soil.*	*Produce per Acre.*
4 Gallons	Wheat	On loamy after beans	45 buſhels.
6 Ditto	Ditto	On poor clay after clover	25 buſhels, 4 gal.
6 Gallons	Barley	On loamy land after turnips	75 buſhels.
5 Ditto	Ditto	On ſandy land ditto	58 buſhels.
5 Gallons	Oats	On ditto after barley	57 buſhels.
3 Ditto	Ditto	On loamy land after barley	76 buſhels.

‡ Cook in Memoirs of the Bath Agricultural Society, vol. IV. p. 328.

Numerous experiments have been deſcribed by writers on huſbandry, in which the drill method has been ſhewn to be greatly ſuperior to that of the broadcaſt for various ſorts of luxuriant vegetable crops, ſuch as peas, beans, potatoes, cabbages, and even turnips in moſt caſes. It has been obſerved by an attentive drill cultivator, that beans, when drilled in two rows, at nine inches, with an interval of twenty-ſeven, if weeded ſufficiently early, and well ploughed between, become quite thick and abundantly productive. And, in planting a coarſe piece of poor land in two different ways with potatoes, the one part in the common lazy-bed manner, and the other in drills of two rows at a foot aſunder, and three-feet intervals between, for the purpoſe of being wrought by the common plough, and which were three times ploughed and once hand-hoed during the time the crop was in the ground; it was found, on the crops being taken up, that the part ſet in drills was by much the beſt, notwithſtanding it had been planted with only about two thirds the quantity of ſeed. And it is aſſerted that, in the ſowing of turnips by means of the drill, beſides their being better, there is a ſaving of four ſhillings the acre in the after-culture of the crop, when drilled at twelve inches apart, and an opportunity afforded of performing the buſineſs in a much more effectual manner *.

And the experiments of another cultivator of this uſeful root ſeem alſo to ſhew that a greater weight of produce may be obtained by ſowing in drills on one-bout ridges, at twenty-ſeven inches diſtance, than in the broadcaſt method, or even in drills, on a level ſurface, at twenty-one inches †.

In regard to the practice of dibbling, though it may, as has been already obſerved, in particular caſes and circumſtances of ſoil and preparation, when correctly performed, have a degree of ſuperiority over the broadcaſt method, from the circumſtance of more air and moiſture being admitted to the plants, and, where the cuſtom of hoeing prevails, from the ſoil being more fully ſtirred; yet, from the expence and difficulty that attend it, and its being conſtantly liable to be performed in an improper manner, it would ſeem to be not only leſs advantageous than the drill method, but leſs capable of being generally applied.

But whatever may be the advantages of particular methods of ſowing, or in whatever manner the crops may be put into the ſoil, it will conſtantly be neceſſary to attend to their being kept as perfectly clean and free from weeds as poſſible by ſome means or other; as it is utterly impoſſible, from the cloſeneſs and

* Exter in Memoirs of Bath Society, vol. IX.

† Jobſon in Communications to the Board of Agriculture, vol. II.

the want of free admiſſion of air, as well as the great conſumption of nouriſhment that muſt be daily drawn from the ſoil, in caſes where ſuch a number and variety of plants are ſuffered to vegetate together, that there can be abundant crops of grain if the buſineſs of eradicating them be either wholly neglected or only performed in a partial manner. Where the mode of putting in the ſeed will admit of it, care ſhould be taken to have the intervals, or portions of ground between the rows, as frequently ſtirred as may be ſufficient for affording the moſt full and perfect vegetation and ripening of the crops.

In the broadcaſt huſbandry, from the plants ſtanding in an irregular manner, the buſineſs of weeding and cleaning can only be performed by the hand with implements of either the forceps or hand-hoe kinds. But where the drill ſyſtem, or that of dibbling, prevails, as there is more regularity in the ſtate of the crops, this may be executed in other ways, and in a more eaſy, expeditious, and effectual manner, by the uſe of horſe-hoes, or other powerful implements of the ſame kind, drawn by horſes.

Hoeing.—This is a proceſs in which the ſoils, by being frequently ſtirred, broken down, and divided, while the crops are growing upon them, are rendered not only more ſuitable for affording ſuch ſupplies of nouriſhment as may be neceſſary, but for providing and continuing that fine ſtate or condition of the mould which is moſt adapted to their perfect growth. It is therefore, perhaps, one of the moſt uſeful and important operations in the practice of drill huſbandry, and one that ſhould never be neglected by thoſe who are engaged in that ſort of cultivation. It is a practice in which various advantageous changes are produced; the weeds that are injurious to the crops, are not only effectually eradicated and deſtroyed, but more abundant and more regular contributions of nouriſhment provided by the different new combinations of air, moiſture, or other matters that muſt take place either within or upon the ſoil, in conſequence of the mold being often turned over: and the crops, by being thus left in a clean and free ſituation, become more vigorous and healthy in their growth. The pulveriſation thus effected, likewiſe leaves the lands in a more open and permeable condition for the reception of the rains and dews into their internal parts; and the fibrous roots of the plants are not ſo liable to be injured by the drying and cracking of the earth about them during hot ſeaſons. There is alſo another effect produced by hoeing, that, in many caſes, may be of great importance; which is, that, by throwing up the mold againſt the ſtems of the plants in the ſpring months, a great increaſe in the crops may be accompliſhed by the

tillering or ſhooting out of new ſtems from the joints about the ſurface that are thus covered with earth, as happens in tranſplanting, and which has been well repreſented by a late ingenious writer *. Beſides, the land thus undergoes conſiderable preparation, and becomes in a more proper and ſuitable condition for the reception of ſucceeding crops †. It is alſo extremely obvious that, in proportion as ſoils are kept in a looſe, mellow, and pulveriſed ſtate, they muſt be more readily and more fully imbued with the various matters that may fall upon them. Thus the different ſubſtances that are precipitated, or come in contact with them, from the ſurrounding atmoſphere, ſuch as rain, ſnow, dew, air, &c. become more intimately and more abundantly blended, incorporated, and combined with each other and with the mold, in ſuch ſoils as are frequently ſtirred and rendered light and open by hoeing, than where they are ſuffered, by neglecting this proceſs, to become hard, compact, and almoſt impenetrable. In ſuch ſituations as where the ridges are high, they ſeldom, indeed, penetrate much below the ſurface, being too readily carried away by the effects of the ſun and wind, from their ſtagnating there, and becoming much expoſed to them.

From the great differences in the nature of ſoils, it is probable, however, that the proceſs ſhould be conducted ſomewhat differently. On the ſtiff, heavy, and loamy kinds of land, or ſuch as are much inclined to throw up weeds, it may be more frequently neceſſary than on ſuch as are light, thin, or ſandy; as in the latter, eſpecially in hot weather, much injury may be ſuſtained by a too frequent expoſure of the internal parts to the action of the ſun and air, by the great exhalation of their moiſture, and other beneficial properties.

It has been obſerved by a practical writer, that the land for the purpoſe of hoeing ſhould neither be in too dry nor too moiſt a ſituation, but in a middling condition, between theſe different extremes. But that on light and dry mellow ſoils the operation may be well performed at almoſt any time; while on the wet and ſtiff ones it can only be done to advantage in ſuch ſeaſons as render them the moſt ready to break and fall down into ſmall particles: as if done when moiſt in any conſiderable degree, much injury inſtead of benefit may be produced ‡. It may, indeed, be remarked, that on the ſandy, gravelly, and all ſuch ſoils as admit the moiſture to readily filtrate and paſs away through them, there can ſeldom or ever be any neceſſity for delaying the proceſs of hoeing on account of the wetneſs of the land; though, in other caſes, it is obvious that

* Darwin's Phytologia.

† Tull's Horſe-hoeing Huſbandry, ch. ix.; and ſection on Fallowing of Land.

‡ Amos on Drill Huſbandry.

much attention muſt be paid to the ſituation of the ground, in this reſpect, before the operation be undertaken.

In reſpect to the methods of performing the work, it was adviſed, by the more early cultivators in this way, and while the large ſpaces were employed, to hoe or turn the ſoil from the rows or ridges on which the plants grow in the firſt operation, and by thus forming a ſmall ridge in the interval, to leave ſlight furrows or channels for the reception of the moiſture and other matters of the atmoſphere on the ſides of the rows of plants, thereby expoſing a large extent of ſurface to the action of the air. And it was conceived ſcarcely poſſible to perform the operation too deep, or come too near the rows of plants, ſo that they were not cut or rooted up; as by thus baring, and nearly expoſing, the roots, no injury was ſuppoſed to be done. And it was further imagined that, in particular caſes, as in expoſed level ſituations, the little ridglets, by being thus raiſed, might afford ſhelter and protection to the rows of plants, and by keeping the roots freer from moiſture, be leſs obnoxious to the effects of the froſts.

It would ſeem, however, to be a better practice, and more conformable to that of garden culture, by which plants are made to grow in the moſt perfect and luxuriant manner, to turn the earth up to the plants during the ſeverity of ſuch ſeaſons, and thus more ſafely prevent the effects of high degrees of cold or froſt upon them. As it is obvious that, by leaving little mold about their roots in the lighter deſcriptions of ſoil, they muſt be conſtantly expoſed to danger from the crumbling down of what remains in the winter ſeaſon; and, on thoſe of a ſtiff quality, by the little channels being formed ſo near them, injury may be apprehended from the ſtagnation of moiſture, and the great degrees of cold produced in conſequence of it. In the ſpring thoſe ridges, that had been formed in the middle of the intervals or ſpaces, were ſplit up and turned back again to the plants, which, from the mellowneſs of the mold, produced by the action of the froſts upon them for ſuch a length of time, was believed to afford more nouriſhment and ſupport to the crops. The ſame ſtate of mellowneſs and pulveriſation may, in moſt ſorts of ſoil, however, be effected without the riſk of expoſing the roots to danger, by a more frequent ſtirring of the ſoil, without forming ridglets in the intervals, ſo as to draw it away from the rows of the crops. And, in addition, there may alſo in this way be injury from the breaking and dividing the fibres and ſmall roots of the plants, the growth of the crops being thereby much checked and retarded.

Though it is probable that much of the advantage of the operation of hoeing may depend upon its being performed exactly at thoſe periods in which the crops firſt begin to decline, and ſtand in need of aſſiſtance, no ſatisfactory experiments

have, perhaps, yet been made with a view to aſcertain the appearances in different caſes with that degree of preciſion which is neceſſary to enable the cultivator to guard againſt ſuch effects by commencing his operations.

It would ſeem, however, that the autumnal hoeings ſhould be accompliſhed at ſufficiently early periods for the crops to become firmly eſtabliſhed in the ſoil againſt the winter ſets in, and the ſpring ones ſo performed as that the growth of weeds may be prevented, and a fine ſtate of ſoil be provided for the coronal roots of the plants to ſhoot into, as about March or April, according to circumſtances. Thus, where wheat has been ſown at ſuch an early period as to admit of the ſoil being ſtirred by the hoe in the autumnal ſeaſon, it ſhould, it is ſaid, conſtantly be accompliſhed ſome time before the winter froſts ſet in; as when delayed too long at ſuch periods, by the ground about the roots of the plants being in this way made light, they may thereby be more liable to be thrown out of the ground during the thaws or heavy rains in the winter.

But the ſecond or ſpring hoeings muſt be executed at different periods, according to the wetneſs or dryneſs of the ſoil, and the nature, appearances, and forwardneſs of the crops; but in general the more early they can be done after the froſts have diſappeared the better; provided the ground is ſufficiently firm to admit the animals employed in performing the operation, without poaching the land and producing injury in that way.

The different after-hoeings muſt conſtantly be regulated by the particular circumſtances of the ſoil and crops, and the judgment of the agricultor, both in regard to the moſt proper periods for the performance of the buſineſs, and the frequency of their being repeated. Three or four may, in general, be ſufficient, where proper care has been taken in preparing the land. It ſhould, however, be conſtantly kept in view, that the vegetation of the weeds be never permitted to advance too far, ſo as, in any degree, to exhauſt the land, or injure the crop, by their luxuriance and ſhade; nor the ſurface of the ground become too firm and hard, ſo as to impede the action of the dews, and the influence of the atmoſphere; as, in particular ſoils, and very dry ſeaſons, much injury may be ſuſtained in theſe ways from the crops not being perfectly fed. And in this laſt intention it may even, in ſome caſes, as where the ſoil has been conſiderably impoveriſhed, be neceſſary to give a further ſtirring to the land at an advanced period, in order to ſupply freſh nouriſhment to bring them to perfection.

On ſtrong and wet ſoils it may, in many caſes, be likewiſe hazardous to delay the firſt or autumnal hoeing too long, on the grounds, that ſuch lands may become too poachy and wet to work in a perfect manner.

Light harrowing and rolling may alſo frequently be practiſed with conſiderable

advantage in breaking down and reducing the lumpineſs of the mold before the buſineſs of ſpring hoeing is begun; but theſe operations muſt be directed by the judgment of the cultivator.

This ſort of buſineſs muſt be performed in different methods, according to the particular circumſtances of the crops. For grain or ſmall ſeed crops, where drilled or ſet with narrow intervals or ſpaces, the operation of hoeing ſhould be performed with hand-hoes, or ſuch implements of the horſe-hoe kind as have ſhares adapted to the diſtances between the rows. But for pulſe crops of different kinds, and all ſuch plants as are ſown or ſet in rows with ſpaces of conſiderable extent, implements of larger dimenſions and of greater ſtrength may be more effectual.

The introduction of the uſe of the hand-hoe for the ſtirring of the earth between the rows of ſuch crops as were drilled or ſet at narrow diſtances, as from ſix or ſeven to nine or ten inches according to the kinds of crop, was for ſome time conſidered as a great improvement upon Mr. Tull's method of drilling or ſetting two rows near together, and leaving wide intervals of two or three feet between the different nearly-planted rows, for the purpoſe of being hoed with horſe-hoes. The hand-hoes employed for narrow diſtances by an attentive and able agricultor*, in wheat and pea crops, are ſaid to be about ſix inches wide, and thoſe for barley about four. And, with implements of this kind, the ſuperficial parts of the ſoil between the rows of grain are not only effectually turned over, and the weeds eradicated, but their growth prevented by the mold being heaped againſt the riſing ſtems of the plants †.

The hand method has, however, by many ingenious cultivators, lately given way to that of hoeing ſeveral rows at a time, by means of horſe-hoes contrived for the purpoſe; a method which is certainly leſs expenſive, and much more expeditious, and in which the paſſage of the horſe amongſt the plants, where that is neceſſary, is ſaid to be of no material injury or inconvenience.

The advantage of this method over that of the hand-hoe muſt evidently be conſiderable from its much greater power in looſening the ſoil, and paſſing to a much greater depth, as well as in doing the work in a more regular and complete manner ‡.

* Mr. Coke, Holkom, Norfolk. † Darwin's Phytologia, p. 438.

‡ The ſuperiority of the method of hoeing by means of horſes, over that by manual labour, will probably be placed in a more clear point of view by the details of the comparative experiments that have been made by an able writer on drill huſbandry. In cultivating an acre of ground, which

But where the proceſs of hand-hoeing is in uſe, which we have ſeen to be often the caſe in diſtricts where the drilling or dibbling of grain in rows at narrow diſtances is practiſed, various implements of the ſmall hoe kind are employed. The old light ſquare form of hand-hoe has now, in moſt caſes of field huſbandry, given way to thoſe of a more weighty and effective conſtruction, by which the buſineſs of hoeing, eſpecially in light ſoils, is not only more quickly

was a light ſandy loam, of the annual value of about twenty ſhillings, under a potatoe crop, in the different methods, the reſults were found to be as follow:

Horſe-hoed Acre.		DR. £.	s.	d.
1789.				
Feb. 2,	Ploughing firſt time -	0	5	0
28,	Harrowing - -	0	0	6
	Dung, twelve loads, and ſpreading - -	0	16	0
March 1,	Ploughing ſecond time -	0	4	0
April 2,	Harrowing ditto - -	0	0	6
24,	Ploughing with 3 ploughs	0	4	0
	Planting 12 hands 3 inches deep, 9 aſunder, with 30-inch alleys -	0	4	0
	Seed and cutting; 30 buſhels at 1s. 4d. -	2	0	0
	Rolling - -	0	0	6
June 1,	Harrowing for 1ſt hoeing	0	0	6
10,	Skim-hoeing firſt time -	0	1	0
	Hand-hoeing the rows -	0	3	0
26,	Skim ditto, ſecond time -	0	1	0
	Hand ditto rows - -	0	3	6
July 1-15,	Earthing up rows twice -	0	2	0
Aug. 2,	Picking out weeds -	0	1	6
Oct. 20,	Taking up, pying, &c. -	1	16	0
	Expences -	6	3	0

Contra.	CR. £.	s.	d.
Produce, 500 buſhels, at 8d. - - -	16	13	4
Profit	£. 10	10	4

Hand-hoed Acre.		DR. £.	s.	d.
1789.				
Jan. 12,	Ploughing firſt time -	0	5	0
Feb. 24,	Drag-harrowing -	0	1	0
	Dung, twelve loads, half charged, ſpreading, &c.	0	16	0
Mar. 2,	Ploughing ſecond time	0	4	0
30,	Harrowing twice - -	0	1	0
April 24,	Ploughing with 3 ploughs	0	4	0
	Planting 12 hands 3 inches deep, 8 aſunder, 24-in. alleys - - -	0	4	6
	Seed and cutting, thirty-ſix buſhels at 1s. 4d. -	2	8	0
June 1,	Harrowing for firſt hoeing	0	0	6
14,	Hand-hoeing firſt time -	0	5	0
26,	Second ditto - -	0	4	0
July 6,	Earthing up - -	0	15	0
Aug. 3,	Picking weeds - -	0	1	6
	Taking up, leading, pying, &c. - -	1	14	0
	Expences -	7	3	6

Contra.	CR. £.	s.	d.
Produce, 420 buſhels at 8d. - - -	14	0	0
Profit	6	16	6
Advantage in favour of horſe-hoed acre - -	3	13	10
	£. 10	10	4

And

and leſs expenſively performed, but the mold ſtirred to a much greater depth. By attending to the above principles, and thoſe of accompliſhing the operation on ſeveral rows at a time, an ingenious cultivator has lately contrived an uſeful tool of this ſort, which hoes three rows at once, and is capable of being varied according to the purpoſes for which it is employed*. In the firſt form, a fine tilth is ſaid to be ſtruck by it into drills for receiving any ſort of ſeeds with much more readineſs than by the ordinary method of ſtriking with the corner of the common ſquare hoe, along any line of direction, as when one drill is cor-

And on an acre of ſtiff hazle-coloured loamy ſoil, of about the ſame annual value, under a cabbage crop, the reſults of trials, conducted in the different methods, were theſe:

Horſe-hoed Acre.

		DR. £.	s.	d.
1790.				
Jan. 14,	Ploughing - -	0	5	0
Feb. 20,	Harrowing twice -	0	1	0
Mar. 11,	Dung, twelve loads, half charged, at 3s. -	0	18	0
14,	Ploughing ſecond time -	0	4	0
April 20,	Drag-harrowing and couching - -	0	3	6
May 14,	Ploughing into four-feet lands - - -	0	4	0
	Five thouſand plants at 2s. 6d. - -	0	12	6
	Planting 48 by 30 inches	0	8	6
June 10,	Ploughing from rows -	0	2	6
	Hand-hoeing and hilling	0	3	6
July 1,	Ploughing to rows - -	0	2	6
20,	Earthing up by horſe-hoe	0	1	6
Aug. 1,	Hand-weeding and vermin killing - - -	0	1	6
	Rent, &c. - -	1	1	0
		4	9	0

Contra.	CR. £.	s.	d.
Dec. 21, Value of produce, 50 tons	10	0	0
Profit -	£. 5	11	0

Hand-hoed Acre.

		DR. £.	s.	d.
1790.				
Jan. 15,	Ploughing - -	0	5	0
Feb. 21,	Harrowing twice -	0	1	0
Mar. 11,	Dung - - -	0	11	0
14,	Ploughing ſecond time -	0	4	6
April 20,	Dragging, harrowing, and couching - -	0	4	0
May 14,	Ploughing third time -	0	4	0
	Plants, 5,500 - -	0	13	9
	Planting 36 by 30 inches	0	10	6
June 10,	Hand-hoeing and earthing up - - -	0	12	0
July 20,	Ditto ſecond time -	0	7	6
Aug. 1,	Hand-weeding, &c. -	0	2	6
	Rent - - -	1	1	0
		4	16	9

Contra.	CR. £.	s.	d.
Dec. 21. Produce, 41 tons - -	8	4	0
Profit -	3	7	3
Advantage in favour of horſe-hoed acre -	2	3	9
	£. 5	11	0

From the expeditious and effectual manner in which the operation is performed in this way, there can be little doubt but that it muſt have an equal ſuperiority in other ſorts of crops.

* Ducket, junior, in Communications to the Board of Agriculture, vol. II.

HAND HOES.

Fig. 1.

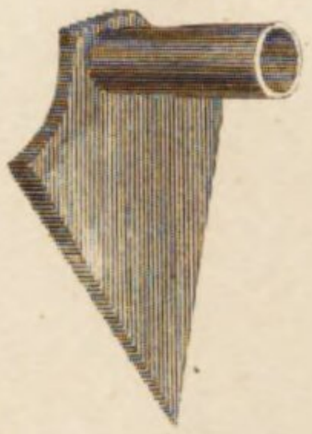


Fig. 7.

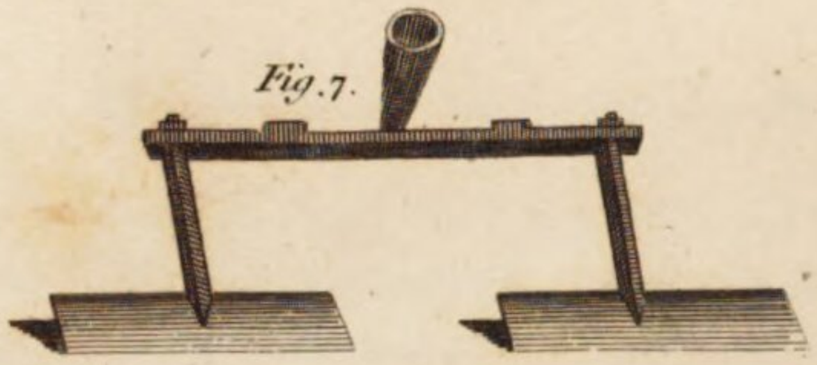


Fig. 4.

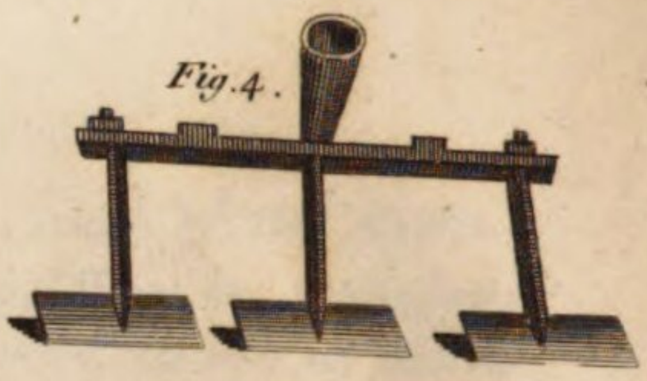


Fig. 3.

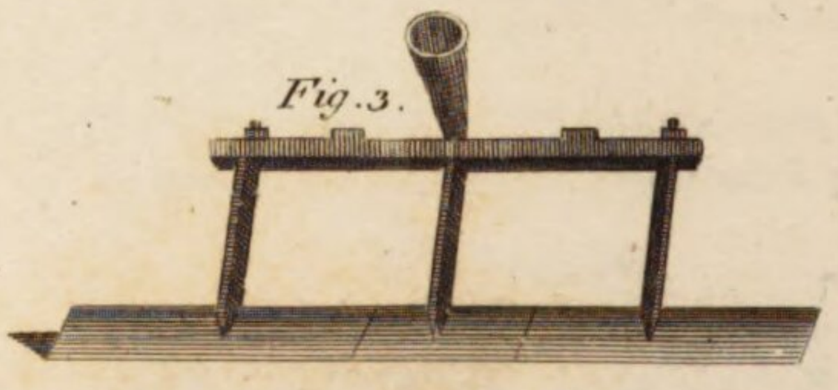


Fig. 6.

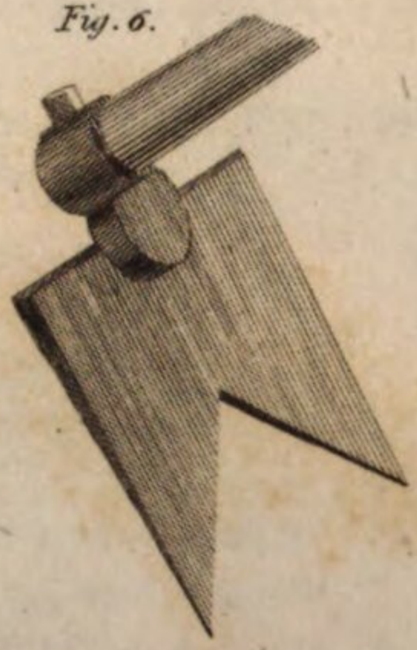


Fig. 5.

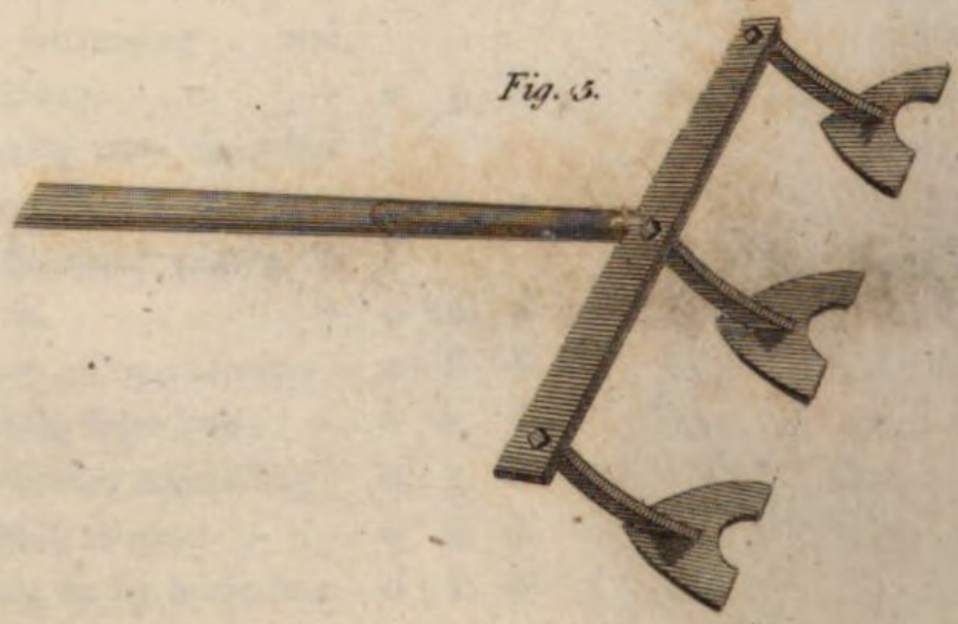


Fig. 2.

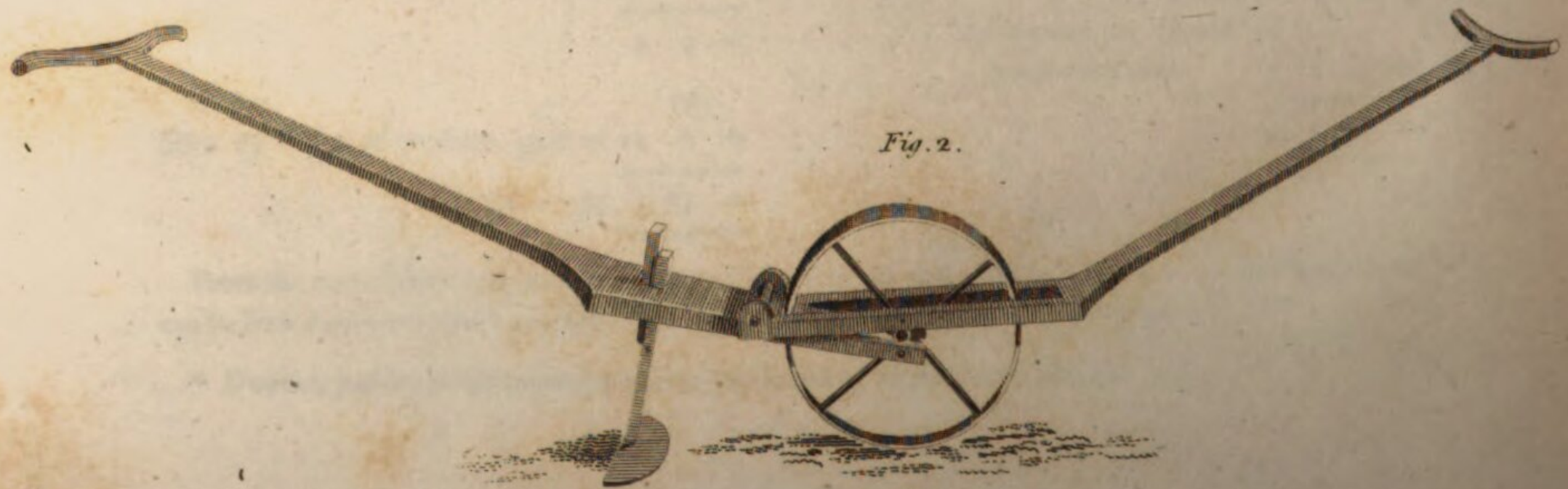


PLATE LI.

Hand Hoes.

[*To face Page* 502.]

Fig 1. Repreſents a *triangular hand-hoe*, which is found more uſeful in ſome caſes than the common ſquare hoe, eſpecially in thinning out crops that ſtand very thick or cloſe together.

Fig. 2. Is the repreſentation of a treble hoe invented by Mr. Ducket, by which three rows are finiſhed at a time, the perſon uſing it *advancing* in the common way. It weighs with the three hart-hoes 7lb. 9oz., and is capable of being uſed by a woman accuſtomed to the work. It is much more effectual in producing a fine tilth in the drills than the common hoe.

Fig. 3. Is another treble hoe for making drills, the ſhares being ſet for drawing, the operator going backwards; and in order to have more preſſure without tiring the wriſt, a rope is added, which, paſſing round the operator's body, draws from that place where the hand would have acted: the weight with two twelve-inch hoes is 7lb. 3oz.

Fig. 4. Shows the hoes as employed in making trenches in gardens, for the reception of manure in planting potatoes; which are formed very expeditiouſly by ſtriking in a line; bringing the mould up into a half ridge, and then finiſhing it by turning and going back. It weighs with three ſtraight ſix-inch hoes 6lb. 11oz.

Fig. 5. Exhibits the two outward hoes, a ſpace being left in the middle for hoeing on each ſide a drill of any ſort of plants with ſafety.

Fig. 6. Repreſents a hand-hoe employed in Portugal with much effect in hoeing the declivities and ſteep ſides of the hills, as well as in other ſituations. It is recommended as a very effective tool by Lord Somerville in his Syſtem of the Board of Agriculture.

Fig. 7. Is the repreſentation of a hoe invented by Mr. Macdougle, which is drawn by a man before and directed by another behind; and is a very uſeful tool for hoeing crops that ſtand at ſufficient diſtances in the rows.

rectly opened, the reſt muſt, of neceſſity, be made with exactneſs. This is made uſe of in an advancing poſture; but it has another form which admits of its being drawn, the perſon uſing it moving backwards, the preſſure being aſſiſted by a rope or ſtrap paſſing from that part of the handle where the hand is applied, round the body of the labourer. The third is ſo contrived, that trenches for potatoes, or other ſimilar crops, can be readily made by it. It has likewiſe another mode of conſtruction, in which a ſpace is left in the middle, that allows of its paſſing on each ſide a row of any kind of plants with great facility, and without any danger of their being injured. Its conſtruction may, however, be better underſtood by the annexed plate. It is aſſerted that two acres of barley may be hoed in a day by means of this implement, and that good work may be made with it in oats and wheat *.

The breaſt-hoes have alſo been recommended, by ſome experienced agricultors, as more uſeful in hoeing grain crops ſown in rows at narrow diſtances, than thoſe of the common kind, from their performing the work in a more perfect and expeditious manner.

The triangular hand-hoe having the point of one of the angles downwards, has likewiſe been found of conſiderable utility in thinning and ſetting out crops, ſuch as turnips, whether ſown in the drill or broadcaſt method.

There are other kinds of hoes which are wrought by the hand, that may be employed for particular purpoſes, but which have been already mentioned †.

It has been remarked by a noble and intelligent promoter of agricultural improvements, in a late work ‡, that the Portugueſe, who conſiderably excel in the uſe of the hoe, have an implement of this ſort, which, by its weight and conical ſhape, and from its handle being light and ſhort, performs its work to a good depth, without requiring much exertion in the perſon that uſes it. They employ it in the breaking up of the ſtrong lands of their vineyards, which could not, it is ſuppoſed, be wrought by hoes conſtructed in the manner that our common ones are. Theſe principles have however been, in ſome degree, applied in the forming of the different ſorts of hand-hoes deſcribed above. It is alſo ſuggeſted, that this implement may be found extremely uſeful in the digging and cultivating of the land of ſteep mountainous diſtricts, as well as in the forming of compoſt manures of lime and earth in the corners of fields where the plough cannot be made to perform the buſineſs, and in very hilly ſituations, where the

* Ducket, junior, in Communications to the Board of Agriculture, vol. II.

† Section on Implements. ‡ Lord Somerville's Syſtem of the Board of Agriculture, p. 156.

ſpade cannot be eaſily employed. On head lands, in arable fields, and in orchards, or other plantations, for hand-digging it may likewiſe, it is ſuppoſed, be found of utility in different caſes *.

The implements that are had recourſe to where weeding the crops by hand-labour is practiſed, are very few, conſiſting principally of a ſort of forceps, or tongs, that act on the principle of the lever, having handles of two or three feet in length, by which they are made to take hold, and force up different ſtrong weeds, ſuch as docks and thiſtles, that cannot be otherwiſe handled ſo as to be drawn up and completely removed.

The prevention of the growth of ſeed weeds is attempted in different methods in different diſtricts; in ſome, as has been ſeen, by the expoſure of the ſoil to the action of the ſun during the hot ſummer months, every third or fourth year, according to the nature of the land, by frequently ploughing and expoſing new ſurfaces †; but in others by the alternate ſowing of grain, and what are termed green crops, and the ſtirring of the earth frequently well between the plants, by means of the hoe, while they are growing. The laſt is undoubtedly the beſt practice in all caſes where the nature of the land will admit of it, as there is no loſs from the land remaining, for a time, in an unproductive ſtate. It is remarked by a late writer, that, in the diſtrict which he deſcribes, on the *ſandy loams* this buſineſs is effected by hoeing the crops of peas, tares, and turnips. On the peas or tares being removed from the ground, the land is ploughed and harrowed, and the *root* weeds burnt, after being brought together by means of raking. And on the land thus freed from *root* weeds, turnips are ſown, and the *ſeed* weeds deſtroyed by repeated hoeing ‡. By a proper attention to the nature of crops, and the cultivation of them in rows, ſo as to admit of a full and effectual application of the hoe while they are upon the ground, it is probable that the growth of weeds may, in moſt caſes, be in a great meaſure prevented, without having recourſe to other more expenſive proceſſes. Even under the broadcaſt culture, a greater regard to the modes of cropping, and a more free and liberal uſe of the hand-hoe and the forceps, may have conſiderable effect in the prevention of the growth of weeds, and the injurious conſequences reſulting from them, as well as in keeping the ſoil in a more mellow and proper condition for the production of uſeful crops of all kinds.

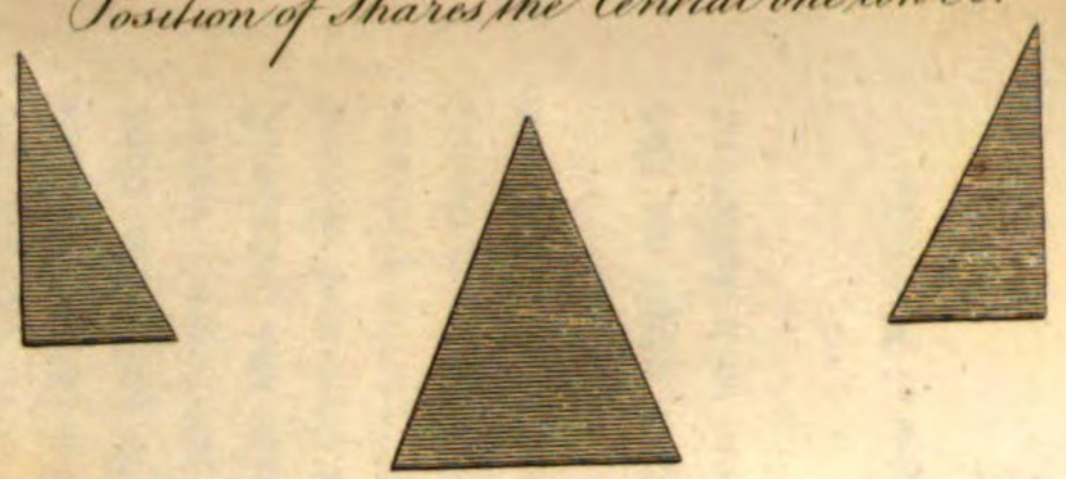
The hand and breaſt-hoes being ſeldom ſufficiently effectual even on the lighteſt deſcription of ſoils, from their not performing the buſineſs to a ſufficient

* Lord Somerville's Syſtem of the Board of Agriculture, p. 156.

† Section on Fallowing of Land. ‡ Middleton's View of the Agriculture of Middleſex.

Position of the Shares on the same level.

Position of Shares the Central one lower.



USEFUL HORSE HOE.

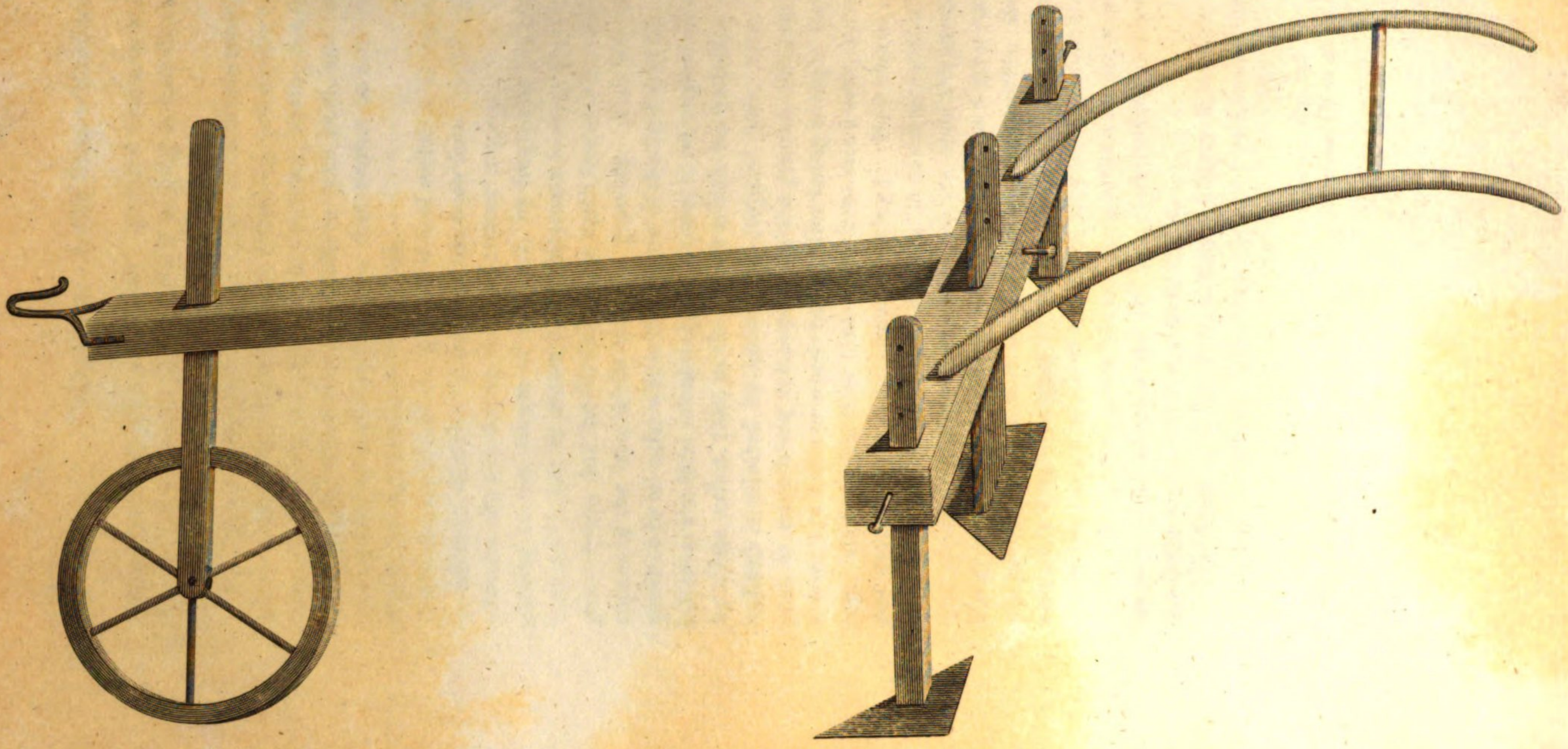


PLATE LII.

Useful Horse-Hoe.

[*To face Page* 504.]

THIS represents a *Horse-Hoe* or *Shim* recommended by Mr. Young, the hint of which he took from the Berkshire one, and to which the beam and block is capable of being applied. He has found it a very useful tool. In a wide interval, the three shares may be worked on a level. Between the rows of cabbages, after earthing up, the two external shares may be set to cut the weeds that are apt to rise on the sides of the ridges, without disturbing too much earth, and the centre share sunk to scrape the bottom of the furrow. The centre one may also be worked alone between narrow rows. In forging the shares of all Shims, Mr. Young well observes, that the blacksmith should be careful to give them tendency enough *into* the ground, bending them downwards: for want of this caution he has found many of them to work badly; the wheel in the beam counteracts this tendency sufficiently.

PLATE LII.

Useful Hop-Hoe.

[To face Page 504.]

Tara represents a Hop-Hoe or Skim recommended by Mr. Young, the hint of which he took from the Berkshire one, and to which the beam and block is capable of being applied. He has found it a very useful tool. In a wide interval, the three tines may be worked on a level. Between the rows of cabbages, after earthing up, the two external tines may be let to cut the weeds that are apt to rife on the fides of the ridges, without difturbing too much earth, and the centre tine ferves to fcrape the bottom of the furrow. The centre one may alfo be worked alone between narrow rows. In forcing the tines of all Skims, Mr. Young well obferves, that the blackfmith fhould be careful to give them tendency enough into the ground, bending them downwards; for want of this caution he has found many of them to work badly; the wheel in the beam counteracts this tendency fufficiently.

depth, thoſe of the horſe kind have become more general. Beſides, thoſe of the former ſort being in every caſe diſadvantageous in point of economy, from the circumſtance of ſo much more work being capable of being performed by thoſe where horſes are employed, the latter are to be preferred in moſt inſtances where the nature of the ſoil and crop will admit of them.

Some ſuppoſe that the great ſuperiority of the horſe-hoe is ſhewn by the fineneſs of the appearance of ſuch crops as have been hoed in that way over thoſe in which the hand method was employed; while, at the ſame time, it demonſtrates that deep and complete ſtirring of the ſoil is in general to be preferred as the moſt beneficial for perfecting the growth of the crops.

In the hoeing of ſuch crops as are drilled at ſmall diſtances, the horſe-hoe annexed to Mr. Cook's drill machine is an extremely convenient and effective implement on almoſt any ſoil.

And for narrow intervals and mellow ſoils, the *expanding horſe-hoe*, invented by Mr. Amos, and the *ſix-ſhared horſe-hoe*, may be found very uſeful and effective implements *. The former has much ſuperiority in conſequence of its expanding ſhares, by which it can be ſet to ſuch diſtances as may be required within the limits of twelve and thirty inches, and, of courſe, be capable of ſtirring the ground in intervals of any diſtance between ſuch extremes †.

It has been found uſeful in hoeing bean crops, whether drilled or ſown in equidiſtant rows; and may likewiſe be applied in the hoeing of potatoe or cabbage crops, as it is capable of performing the buſineſs in a tolerably complete and expeditious manner.

The harrow which is attached to it may be uſeful in particular caſes, as where the land is diſpoſed to throw up ſucceſſive crops of weeds, and in the preparation of it for the reception of crops.

The ſix-ſhared horſe-hoe, from its being regulated in reſpect to the rows, may alſo be made uſe of for grain crops where the diſtance is but ſmall, as nine inches. It may likewiſe be employed in the preparation of the more ſtiff, gravelly, and ſtony deſcription of ſoils, or ſuch as are infeſted with weeds, by ſubſtituting the coulters in the places of the triangular hoes. The coulters being ſo contrived as to cut and divide the upper parts of the earth at the ſame time that the inferior parts are effectually ſtirred.

But for performing the buſineſs, in particular caſes, the ſame practical agricultor has recommended the uſe of a ſmall *Rotheram plough*, or a common plough of any diſtrict, made upon a ſmall ſcale, with a broad ſharp ſhare; on ſtiff ſoils, where the nature of the crops will admit of wide intervals, he thinks ſuch ſorts of ploughs

* Amos on Drill-huſbandry. † Section on Implements.

preferable to all other kinds of hoeing implements; as they can be made to go to any depth required, and be wrought very near the rows, at the expence of merely the labour of one horſe where the ſoil is of the light kind, and in a fine ſtate of tillage. And another deſcription of plough that may be of great utility in this buſineſs in earthing up the rows of plants on each ſide at once, is that with two expanding mold-boards, as by this means much work can not only be expeditiouſly performed, but the mold laid up to ſuch heights as may be thought the moſt advantageous to the plants.

But it is maintained by an able writer on rural economy, that all the different operations of the horſe-hoeing kind may be effected by means of the common *ſwing-plough*, and in a much more complete and perfect manner, than by the aſſiſtance of the hoe or double-mold-boarded plough, which is commonly made uſe of for this ſort of buſineſs *. The proceſs of horſe-hoeing, as deſcribed and recommended by Tull, Chateauvieux, and other writers of the ſame period, is, he thinks, objectionable on different grounds. From the earth in the firſt operation being turned away and removed from the rows of the plants by the furrows being drawn on each ſide of them, and turned towards the intervals, the roots of the plants muſt be left naked and expoſed on each ſide at the ſame time; and the narrow ſtrips or ridglets on which they are placed, from being in this way rendered dry and hard by the powers of the ſun and wind, be rendered leſs proper for the ſupport of ſuch plants, and conſequently greatly retard and injure them in their growth, unleſs it be prevented by ſuch other means as have a tendency to obviate the advantageous effects of the proceſs, ſuch as that of neither going in any degree ſo near the rows of plants on either ſide, or ſo deep, as might otherwiſe be the caſe with ſafety, but in ſuch a manner as to leave a conſiderable portion of earth for the roots of the plants to bed and extend themſelves in; and ſo that there may be ſufficient reſiſtance afforded by the ridglet on the left-hand ſide of the plough, to enable it to turn up the neceſſary parts of the ſolid earth on the right-hand ſide; and further, that inſtead of its going directly downwards near to the rows, be ſo managed as to form the cut obliquely outwards, in order to guard againſt the mouldering down of the earth from the upper parts, and leaving the roots of the plants expoſed. Theſe combined circumſtances render it clear, that a large proportion of the ſoil muſt remain unſtirred near to the place where the plants grow, and which, of courſe, can derive no advantage whatever from the proceſs of hoeing.

The ſecond proceſs, or that of turning the earth back towards the rows, is uſually performed by a double-mold-boarded plough paſſing down the middle be-

* Anderſon's Recreations in Agriculture, vol. II.

HORSE HOEING.

Fig. 1.

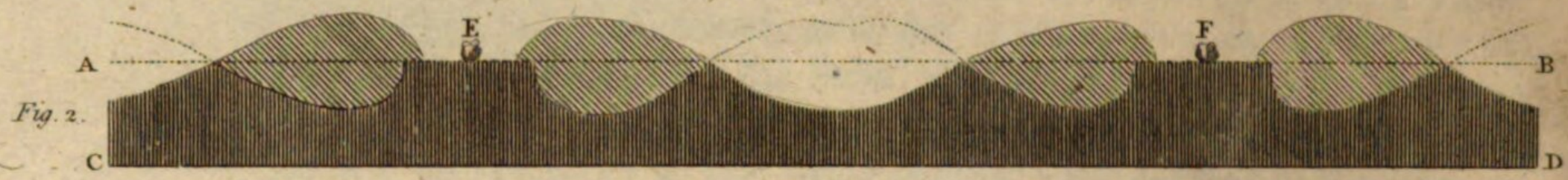


Fig. 2.

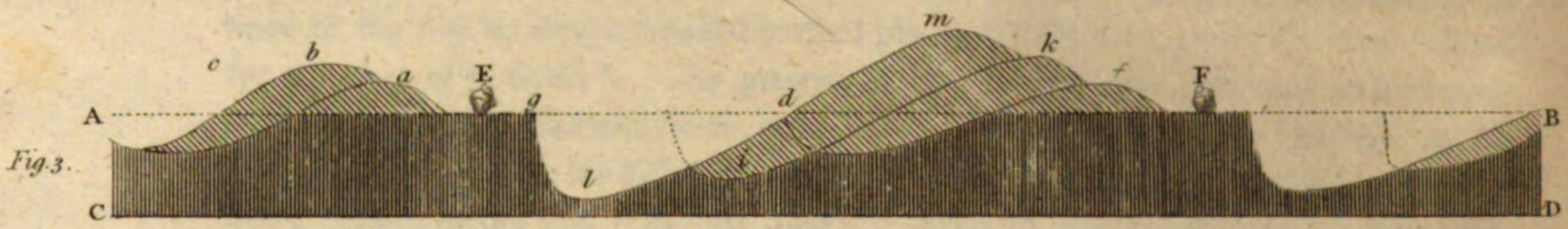


Fig. 3.

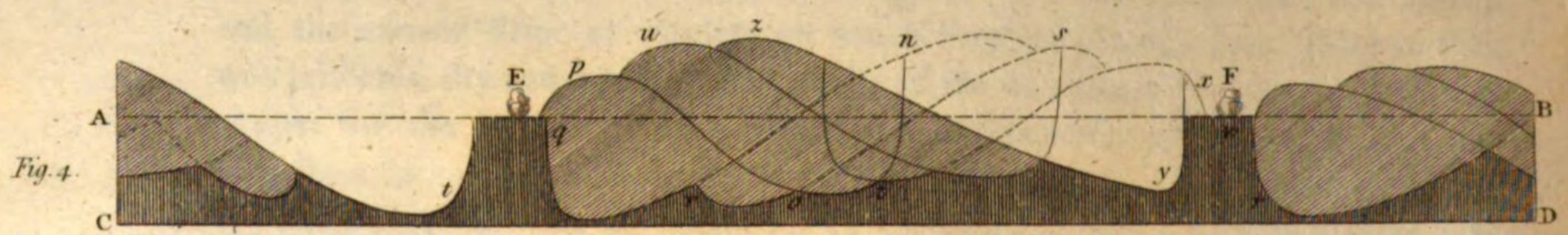


Fig. 4.

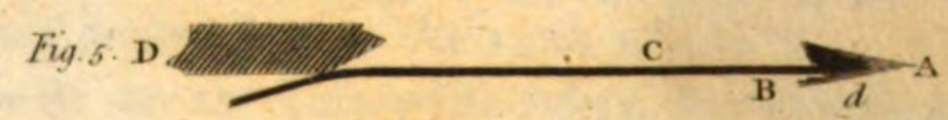


Fig. 5.

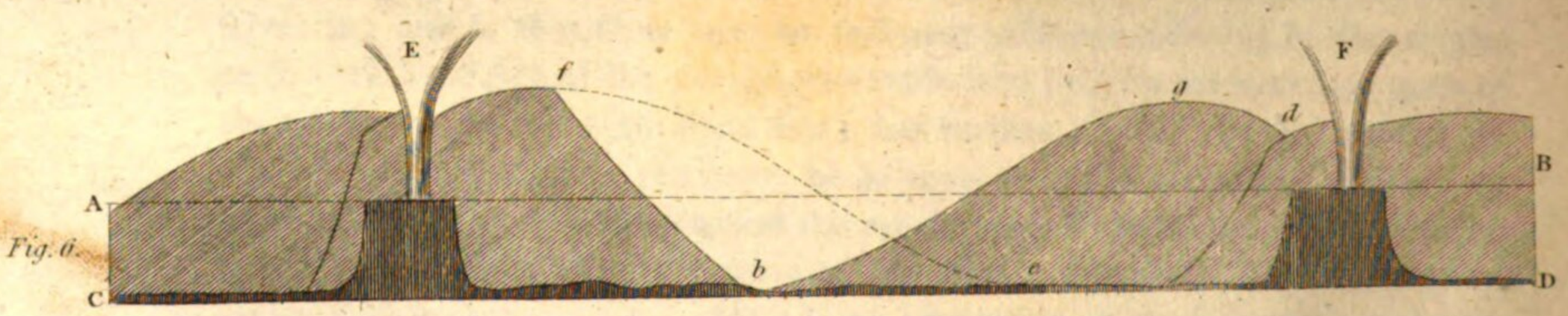


Fig. 6.

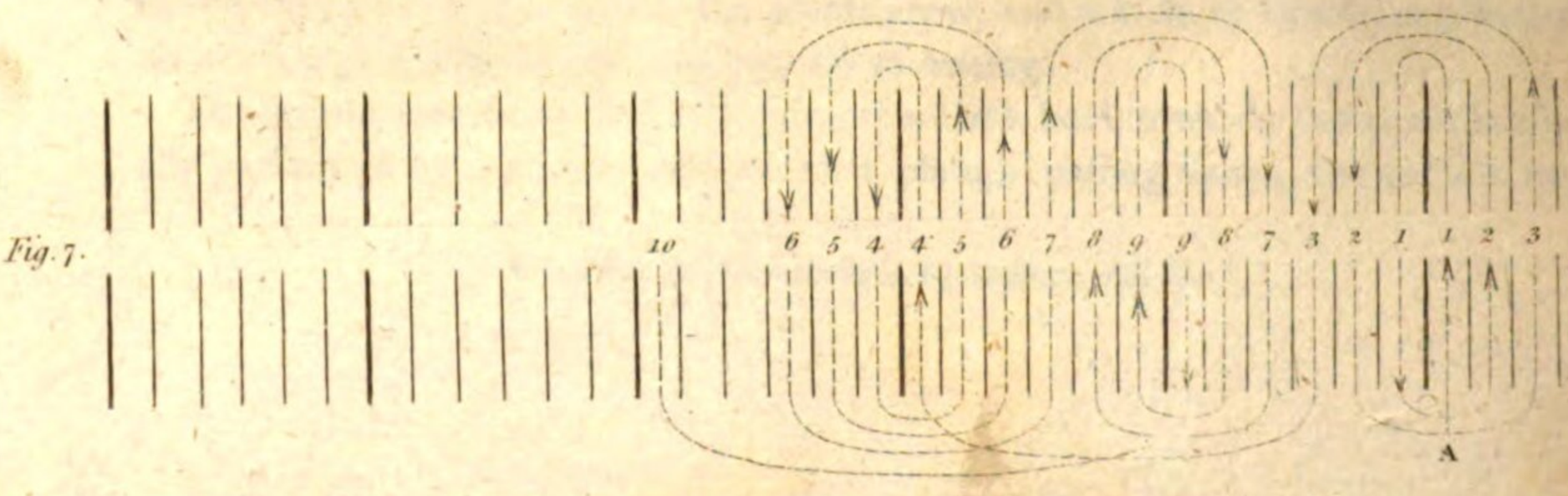


Fig. 7.

PLATE LIII.

Horſe-Hoeing.

[*To face Page* 507.]

In illuſtration of the nature of horſe-hoeing by means of the ſwing-plough, *Figs.* 1 and 2 repreſent the ſurface of a ploughed field by the lines AB, AB, and CD, CD the bottom of the ploughed part of the field, which is ſix inches in depth; this being the whole of the bed in which the plants are to find their nouriſhment. FF repreſents two rows of plants intended to be horſe-hoed, that are placed at three feet apart. At the firſt operation the plough makes the furrow *b*, *c*, *e*, *Fig.* 1, turning the earth from the row of plants E; and returning on the other ſide of the row makes the furrow *a d l*, leaving the row of plants E ſtanding upon the eminence *d a b c*. The ſame operation being performed on the row F, it is left as in the figure, and ſo through the whole field. The furrows in this caſe are repreſented as going to the depth of three inches, and the diſtance *a b* is nine inches, and made to approach nearer to the row E on each ſide, and to go perpendicularly downward, ſo deep as to reach the bottom of the manured ſoil, as is repreſented by the dotted lines *f h i* and *g k l*. It is evident that the ſmall pillar of looſe earth *f h g k*, deprived of all ſupport on the oppoſite ſide, could not have reſiſted the preſſure of the plough while it forced out the earth in the oppoſite furrow; nor have ſtood in this poſition, or retained moiſture to preſerve the plants alive.

Fig. 2. Repreſents the ſame field as it is left after the ſecond operation, in which the furrow made by the double-mould-board plough is repreſented as four inches deep (being eight inches perpendicular from the ſurface of the raiſed up earth). Little of the mould can be actually removed by theſe operations, though repeated ever ſo often; more than three-fourths of the vegetable mould remain untouched.

Fig. 3. Repreſents the ſame field as before, with the rows of plants EF growing upon it. But inſtead of beginning the firſt hoeing, as before, by running the plough along the right-hand ſide of the row E, go along the left-hand ſide of it, ſo as to lay the earth toward that row, as at *a b c*. Having performed this operation on the left-hand ſide of the row E, and ſuppoſing the plough brought back to the ſame end of the field, ſuppoſe it to begin between the rows E and F, by drawing the furrow marked *d e f* (the ſpace between *d* and *g* being preſumed to be at this time ſolid mould), ſo as to turn the earth toward the row F. Then (the plough being again brought back to the ſame end as at firſt) draw the furrow *h i k*, which, by having had an open furrow to the right-hand ſide of it, can be with eaſe made deeper than the former. Then, by going a third time in the ſame direction, draw the furrow *g l m*; going in this caſe as cloſe to the row as you pleaſe, as the ſolid earth on the back of it prevents it from being deranged. In this way, by this firſt operation, a much greater proportion of the mould is turned over than by the common proceſs, as in *Fig.* 1; the black part of the figures in both caſes repreſenting the part of the mould that is left untouched.

Fig. 4. Repreſents the field after it has undergone the ſecond hoeing; in which the dark parts repreſent the mould that has been left untouched. In this operation all the ſteps of the laſt hoeing are directly reverſed: inſtead of beginning at the back of the row E, and, turning the furrow towards it, the plough begins on the right-hand ſide of the row F, and going in an oppoſite direction, turns the furrow towards the row F. That done, ſtill holding the ſame direction, it is made to paſs between the rows F and E, ſo as to open the furrow *n o p* (the dotted line *q r n* repreſenting the open furrow that was left in the firſt hoeing). A ſecond furrow is then drawn in the ſame direction, ſo as to form the opening *s t u* (the dotted line *n s x* repreſenting the ſurface of the mould as left at the laſt hoeing); and a third furrow, drawn in the ſame direction, leaves the opening *x y z*; in which ſituation it remains till the third hoeing commences.

Thus every inch of the mould, except perhaps the ſmall bit *q t w r* under each row, will receive nearly as complete and thorough a ſummer fallow as if no plant whatever had grown

upon the ground. Which if compared with *Fig.* 2, the difference between the merits of the two operations will be obvious. But if at the laſt hoeing the field had been left as repreſented by the dotted line *d e f*, *Fig.* 5. having the furrow turned toward the row F, and the earth ſtrongly laid up to the ſtems of the cabbages, the plough, when it is intended to finiſh off the operation, ſhould be introduced ſo as to turn the earth toward the row E. In that caſe, the operator, by inclining his plough a little to the left, makes it cut in an oblique direction, inſtead of perpendicularly, as he has hitherto invariably worked; and, ſtriking deep, ſo as to go quite to the bottom of the manured mould, he forms the opening *f b g*, ſo as to leave a clear opening in the middle, with the looſe earth cloſely laid up to each ſide.

Fig. 6. Shows the mode of returning the plough ſucceſſively to the ſame place without any loſs of labour, the black lines on which are intended to repreſent rows of plants of any kind, on a field regularly laid out for horſe-hoeing. Suppoſe the plough to ſtart at A, and, going right forward, it enters the field on the right-hand ſide of the row marked B; and proceeding forward to the other end of the field, it opens a furrow, laying the earth from the row B toward the adjoining row to the right; then turning to the left hand, it returns on the other ſide the ſame row, laying the furrow from it on that ſide alſo. In this inſtance, the row B will be left preciſely in the ſame ſtate as every row is left after the firſt hoeing in the Tullian method. The plough proceeding forward to the end where it began, or the lower end of the field, it then turns to the left, and goes up the row 2, having the ſecond row (or that row toward which the earth moved by the laſt furrow was laid) on its left hand, ſo as to turn the earth from it on that ſide. Proceeding forward, it turns at the head toward the left hand again, and returns down the furrow 2, leaving that row in the ſame ſituation as the former. After the ſame manner proceed, widening always as you go round, and turning ſtill to the left, till the rows become ſo far aſunder as to make it inconvenient to turn longer in that direction. When you find it neceſſary to ſhift a new ridge on account of its width, being returned to the ſame end from which you began, count the number of furrows opened, multiply half that number by three; then, beginning from the point where you ſtand, ſet off as many intervals as make up the number you have found; and then mark the row where you ſtop. In the figure the ridge conſiſts of ſix rows; and as three is the half of ſix, and three times three make nine, it follows that, paſſing theſe nine intervals, you mark the tenth row, which falls on the row *c* marked on the figure. Move the plough then from where it ſtands, as marked by the dotted line and darts, and enter it on the interval on the right-hand ſide of the row C; proceed exactly as at firſt, till you open ſucceſſively the furrows 4, 5, and 6, both going and returning, as marked by the dotted lines and darts in the figure. There now remains a ſpace of ſix rows between 3 and 6, which is untouched. Turning the plough ſtill to the left, as before, open the furrow 7 going upward; but, inſtead of turning to the left at the top of the ridge, now turn to the right, and go down the furtheſt untouched interval, opening the furrow 7 on the return. At the bottom, turn ſtill to the right, and ſo again at the top, opening up ſucceſſively the furrows 8 and 9, where you cloſe, turning the earth on both ſides towards D, ſo as to leave it exactly in the ſame ſtate as a Tullian row would be left after the ſecond hoeing. The plough, when this is finiſhed, comes out at E, whence it may proceed to another. By beginning at A, and following the dotted lines in the direction of the darts, the progreſs may be regularly traced throughout the whole proceſs. Proceed regularly after the ſame manner till the whole field is gone over, and obſerve that every ſubſequent hoeing is performed by directly reverſing this; beginning always in the ſecond hoeing where the firſt left off, and leaving off where it began, making the plough go in a contrary direction; ſo as to begin at the bottom in the interval 9 on the right-hand ſide of the row D, and return downwards in the interval 9, and ſo on till the whole is completed.

This method is deſcribed and recommended by Dr. Anderſon.

tween the rows, ſo as to divide the ridglet equally, and throw up a part to each row. By this means the looſe mold that was turned from the rows in the preceding operation, is now returned back to them, together with a portion of the ſolid earth from the middle. It is, therefore, evident, that ſo ſmall a portion of the ſolid parts of the earth is ſtirred in this way in this part of the proceſs, that but little advantage can be gained by the crops in proportion to what might be the caſe by a more full, effectual, and complete ſtirring of the various parts of the ſoil. And as the whole of the buſineſs of this ſort of hoeing conſiſts in the mere repetition of one or other of the above operations, it muſt follow that much of the ground muſt be left unſtirred, and of courſe not pulveriſed or expoſed to the ameliorating influence of the atmoſphere, by which new and more abundant ſupplies of food may be prepared, and the growth and vigour of the plants be promoted in the moſt full and complete manner.

But in order to place the defects of this ſyſtem of horſe-hoeing in a ſtill more clear point of view, and to ſhew the ſuperiority of that by means of the common ſwing-plough, the ingenious author juſt mentioned has accompanied his deſcriptions of the different proceſſes with figures or repreſentations of the manner in which the hoeing is to be performed in each caſe, and which may be ſeen conſiderably enlarged in the annexed Plate.

The perfect kind of hoe-culture that can be given by means of the common plough, when applied in the manner that has been juſt recommended and explained, will, it is conceived, render the plants capable of advancing with a degree of vigour that can never be attained under any other circumſtances. The ground will be kept conſtantly moiſt, ſo that in the drieſt ſeaſons ever experienced in this climate their leaves will exhibit the moſt healthy verdure, and extend to ſuch a length, in turnips and cabbages eſpecially, as quickly to cloſe upon each other, and in a ſhort time leave no appearance of the rows. But, in order to prepare for this, it is obſerved, that the operations ſhould be haſtened, ſo as to put the ſoil into the fineſt poſſible tilth before the hoeing be finally cloſed; after which time the roots muſt be left at full liberty to ſpread with freedom in the fine mold that had been prepared for them; and the plants will thus be made to attain the utmoſt degree of perfection of which they are ſuſceptible.

This method of performing the buſineſs of horſe-hoeing has been practiſed by the inventor for more than twenty years, without having recourſe to any other, and afforded the moſt full and complete ſatisfaction. It has likewiſe been employed by others, to whom it had been recommended by the author, with the moſt complete ſucceſs; and, in conſequence, been conſidered as a very great improvement in the mechanical department of agriculture. It has alſo been

ſuggeſted as well ſuited to the culture of the ſugar-cane in the Weſt Indies; and that, beſides improving the tilth of the ground in ſituations where it could be employed, the quantity of produce would be incalculably increaſed, and the land kept in order at much leſs expence than in the common mode of cultivation. The crops in this way would, it is ſuppoſed, not only be more luxuriant, but leſs expoſed to danger from dry ſeaſons; the land continue longer capable of ſupporting the plants without being exhauſted, and the operations of planting be finiſhed with much greater expedition in bad ſeaſons; beſides, the danger of vermin would be conſiderably diminiſhed *.

Rotation of Crops.—The proper cropping of arable land is a matter of the utmoſt importance to the intereſts of the farmer, as upon it in a great meaſure muſt depend the profits and advantages which he is to derive from his labour and induſtry. It is conceived by an experienced agricultor in the weſtern part of the kingdom, to be "the moſt prominent feature in good farming;" and that by which the produce of the ſoil may be increaſed in a three-fold proportion †. And by another, in a more ſouthern diſtrict, as one of the moſt important ſubjects that can occupy the attention or exerciſe the ingenuity and ſkill of the agriculturiſt ‡.

That it demands much regard by the cultivator is fully evinced by the great advantages that have been gained by it within the laſt twenty or thirty years, ſince its principles have become more perfectly underſtood, and more extenſively applied. It has, indeed, been well remarked, that wherever either very good or very bad huſbandry is found on arable land, it reſults more from the right or wrong arrangement of crops than from any other circumſtance. And that no diſtrict is well cultivated under bad rotations, while it is exceedingly rare to ſee any badly managed under good ones ‖.

In the arrangement of this buſineſs, as it has been ſeen that different ſorts of plants or crops may not only require different kinds and proportions of nutritious materials to be drawn from the earth for their increaſe and perfect growth, but alſo different ſituations and conditions of ſoil; it muſt be neceſſary to adapt them, as much as poſſible, to the peculiar qualities of the ſoil, as well as the ſtate of the land, and the nature of the climate in which it is placed: and as, on the ſame principles, ſome ſorts of crops may exhauſt or deteriorate the ſoils on which they grow in much leſs proportions than others, as is well known to be the caſe with many kinds of what are termed *green* crops, when compared with

* Recreations in Agriculture, &c. vol. II. p. 345.

† Billingſley's View of the Agriculture of Somerſetſhire.

‡ Middleton's Report of the State of Agriculture in Middleſex. ‖ Young's Annals, vol. XXIII.

thoſe of the *white* or corn kind, it will be requiſite to alternate or interpoſe them in ſuch a manner, as that the ground may ſuſtain the leaſt poſſible injury in that way. In addition to theſe, it may likewiſe be of great utility to attend to other circumſtances, as thoſe of introducing ſuch ſorts of green crops as are moſt ſuited, by the ſhade of their leaves and the kind of culture which they require while growing, for keeping the ground clean from weeds, and in a mellow and ſuitable ſtate for the reception of the more valuable kinds of grain crops, as in this way the neceſſity of having recourſe to the uneconomical proceſs of fallowing may be conſiderably leſſened *.

And as moſt ſorts of ſoils, when continued for any great length of time, either under grain or graſs, are liable to ſuſtain injury, and become leſs capable of producing full crops ;—in the firſt caſe, probably from the carbonaceous principle being too greatly exhauſted ; and in the latter, from the occurrence of moſs, or other noxious vegetable productions, that eſtabliſh themſelves in conſequence of the weak and imperfect growth of the graſs plants ;—it may be proper to occaſionally alter and change the nature of their crops, by keeping them for a while, after being broken up from graſs, under the plough, and then reſtoring them again to the ſtate of graſs ; as, in this way, the deficient principles may probably be the moſt readily ſupplied where manure, in ſufficient quantities, cannot be procured, and the injurious vegetable products be the moſt effectually removed.

It is likewiſe to be conſtantly kept in view, in directing the modes of cropping lands, that ſuch an intermixture of green, root, pea, bean, and grain crops be grown, as will not only be beſt adapted to keep the ſoil in the moſt perfect order, but ſuit the demands of the agricultor, for the purpoſes of ſale, as well as the keeping of ſuch numbers of different ſorts of live ſtock as may be proportionate to the ſupplying of thoſe quantities of manure that may be requiſite for preſerving the farm in the moſt perfect condition.

* It is remarked by Mr. Middleton, in the work quoted above, that "the aggregate benefits that will be derived to the country from this meaſure, are not to be eſtimated : but among the firſt of theſe will ſtand the *abolition of fallows*, and the introduction of *green crops* to ſupply their place, over an extent of *about three millions of acres of arable land*, which have hitherto, under the fallow ſyſtem, produced nothing uſeful during the fallow year. So far as tares and turnips, or potatoes ; or peas and turnips, or potatoes ; or any *two good crops*, can be raiſed in one year, in place of a fallow, the produce will be *double* in quantity what it has been under the former ſyſtem †."

† "There are," it is added, "about nine millions of acres in England and Wales, in the courſe of two crops and a fallow ; *i. e.* ſix in crop and three in fallow. Hence it follows that, by procuring *one* crop in lieu of the fallow, fifty per cent. is added to the former produce. But ſo far as *two* crops can be obtained in place of a fallow, it adds 100 per cent. or double the former number of acres of produce."

In regulating the courſes of crops on all deſcriptions of land, with the view of preventing their exhauſting the ſoil, it will be neceſſary to guard againſt the occurrence of grain, potatoe, or other crops of a ſimilar kind in ſucceſſion, as the reſult of experiments attentively made, as well as the experience of the moſt correct agricultors, in different diſtricts, have decidedly ſhewn their effects to be very powerful when employed in ſuch a manner, in deteriorating and leſſening the productive powers of the ground. In the trials of Mr. Arthur Young, which ſeem to have been conducted with a conſiderable degree of accuracy and attention, on a ſoil of the ſandy loam kind, incumbent on a wet clay marle bottom rendered dry by means of hollow draining, and of the annual value of about fifteen ſhillings the acre, broken up from the ſtate of graſs under which it had been for a great length of time, and ploughed into ridges in contrary directions each ſucceeding year, no manure being applied except on particular lands or ridges in the fourth; though two or three white crops in ſucceſſion were found to exhauſt in a high degree, potatoes had a ſtill greater effect in the ſame way, much more than barley in moſt caſes, and in ſome courſes even more than wheat *.

The reſults of theſe trials are equally curious and intereſting, as they not only demonſtrate the advantages that may ariſe from the alternation of different ſorts of crops in different ways, but the effects of various rotations, both good and bad, upon the ſoil, and the produce derived from it. They would, however, have been more ſatisfactory if the nature of the land had admitted the turnip and cabbage crops to have been conſumed upon the ground, as no certain concluſions can probably be drawn where this is not the caſe; for though a proportionate quantity of manure may be afterwards returned to the land, its application in that way does not ſeem to afford ſuch beneficial effects as when gradually incorporated with the ſoil during the time the animals are feeding on it, upon ſuch luxuriant vegetable ſubſtances. Beſides, the effects of the urine and perſpiration, which are known to be of conſiderable utility in ameliorating the earth, are wholly loſt.

Tare, clover, and other graſſes of the artificial kinds, ſhould likewiſe have been introduced, as by ſuch kinds of crops the rotations would not only have been more varied, but the effects of different combinations more fully ſhewn †.

* Annals of Agriculture, vol. XXIII.

† It is ſtated by the ingenious experimenter, that all the work of tillage was performed by the common implements of the farm, and that the crops, in the whole of the thirty-ſix courſes, were reaped and threſhed directly diſtinct from each other, to obviate the danger of mixing and errors; and that they are minuted acreably to ſave the trouble of calculation. In the valuation, all the ſtraw is rated at 10^{s}. an acre, and the crops are likewiſe eſtimated, that the fluctuations of price may not affect the ge-

But, in order to afford the moſt full and complete view of the effects of different rotations of crops, it would be neceſſary to compare them on ſoils of different qualities, and which vary much in reſpect to ſoil, climate, and ſituation.

ROTATION I.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	. 3 qrs. 1 buſhel . .	4	5	0
2 Turnips	8 tons 6 cwt. . .	1	13	0
3 Wheat	. 2 qrs. 5 buſhels . .	5	15	0
4 Potatoes	. 234 buſhels . . .	5	17	0
5 Beans	. 3 qrs.	4	2	0
6 Wheat	. 3 qrs. 3 buſhels .	7	5	0
		28	17	0
Per annum	. £.	4	16	2

ROTATION II.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	. 3 qrs. 1 peck . .	4	2	9
2 Cabbages	6½ tons . . .	1	12	6
3 Wheat	. 2 qrs. 5 buſhels .	5	15	0
4 Cabbages	7 tons . . .	1	15	0
5 Beans	. 3 qrs. 7 buſhels .	5	3	0
6 Wheat	. 3 qrs. 3 buſhels .	7	5	0
		25	13	3
Per annum	. £.	4	5	6½

ROTATION III.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	. 3 qrs. 1 buſh. 1 peck	4	5	9
2 Potatoes	150 buſhels . .	3	15	0
3 Wheat	. 2 qrs. 2½ buſhels .	5	2	6
4 Cabbages	5½ tons . . .	1	7	6
5 Beans	. 3 qrs. 5 buſhels .	4	17	0
6 Wheat	. 3 qrs. 1 buſhel . .	6	15	0
		26	2	9
Per annum	. £.	4	7	1½

The able experimenter has thrown out many uſeful obſervations on the different courſes, which we ſhall preſent to the reader in as conciſe a manner as poſſible.

The effects of the above rotations lead to different concluſions; in the firſt, in which there are four green fallow crops to two of the white or grain kind, little advantage is ſhewn except in the leaving of the land in fine tilth, and perfectly clean. Nothing of ſuperiority is ſhewn, it is obſerved, by the quantities of produce for lands newly broken up. It is, however, well remarked, that the turnips, by being drawn and removed from the land, were not favourable, as wheat on turnip ground is not generally good, except well trodden by feeding. Potatoes appear to exhauſt; and the experimenter ſuggeſts, that, eſtimating thirty tons of yard

neral concluſions;—the turnips at 4s. a ton, carted off; cabbages at 5s.; wheat 5s. a buſhel; barley 2s. 6d.; oats 2s. 3d; beans 3s.; potatoes 6d.: any other value may however be put upon them according to circumſtances.

compoſt, the proportion employed, at any imaginable rote, the courſe cannot be adviſable; the loſs on the potatoe crop would not, he thinks, be leſs than five pounds, nor would the turnips pay ſo as to leave a profit equal to the expences of newly broken up land for the firſt ſix years *.

The ſecond is ſtated as a more profitable courſe from the great charge of the potatoes not being incurred: and it ſhews, that though cabbages cannot be grown to any great advantage on ſuch ſoils without manure, they may be of much utility by the pulveriſation and cleanneſs which they afford. The goodneſs of the grain crops evinces, it is ſuppoſed, that they exhauſt but little, and that it is of great importance to have few white crops in rotations. And the third explains the neceſſity of manuring for potatoes on all ſoils, except ſuch as are rich and dry; with only two white crops in ſix years, the land ſeems rather, it is obſerved, to improve notwithſtanding the potatoe crop. The goodneſs of the laſt crop of wheat, in compariſon with the firſt, proves the ſuperiority of cabbage and bean crops over thoſe of beans and potatoes, in cleaning and rendering the ground mellow and fit for the growth of wheat.

ROTATION IV.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 1¼ buſhel	4	5	9
2 Beans	4 qrs. 2 buſhels	5	12	0
3 Wheat	2 qrs. 3½ buſhels	5	7	6
4 Cabbages	6½ tons	1	12	6
5 Beans	4 qrs.	5	6	0
6 Wheat	3 qrs. 1 buſhel	6	15	0
		28	18	9
Per annum		£. 4	16	6½

ROTATION V.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 2 buſhels	4	8	0
2 Barley	3 qrs. 1 peck	3	10	7
3 Wheat	2 qrs. 2 buſhels	5	0	0
4 Barley	2 qrs. 2 pecks	2	11	5
5 Beans	2 qrs.	2	18	0
6 Wheat	1 qr. 7 buſhels	4	5	0
		22	13	0
Per annum		£. 3	15	6

ROTATION VI.

Courſe.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 1 buſh. 1½ peck	4	5	5
2 Wheat	2 qrs. 7 buſhels	6	3	0
3 Wheat	1 qr. 6 buſhels	4	0	0
4 Wheat	2 qrs.	5	2	6
5 Beans	1 qr. 7 buſhels	2	15	0
6 Wheat	1 qr. 4 buſhels	3	10	0
		25	15	11
Per annum		£. 4	6	0

* Young's Annals, vol. XXIII.

The results of these courses are highly interesting and important; by the first the utility of repeated bean crops in cleaning land, and when combined with cabbages in preserving the fertility of such as is newly broken up, is clearly shewn. When compared with the first rotation, which ends in the same way, its advantages also appear great in different other respects. By the two last the disadvantages attending successive crops of corn are particularly brought to view. It is well remarked by the intelligent experimenter, that they also shew that any sort of corn crops will succeed to a certain extent on lands recently broken up from the state of old grass; and that for the first two or three years they may afford a produce proportionate to the sort of crop that is sown. But that the three last years, on being compared with the three first, the whole still in corn, the product was in the proportion of *9l.* 14*s.* 5*d.* to 14*l.* 18*s.* 7*d.* or a decrease of more than *5l.*; while, in the preceding courses, with better rotations, the products have somewhat increased. The difference, he says, is therefore enormous. The decline in the barley, and even the wheat crops, notwithstanding the intervention of beans in the latter case, is very great. Besides, they leave the land in a bad condition, being in the fourth and sixth years such a bed of weeds as could not be half destroyed by the hoeing of the beans. In these instances the land not being left worth eleven shillings an acre, while in some of the preceding it was left of the value of sixteen. These, it is well observed, are the prejudicial effects of adopting bad rotations of cropping, from the circumstance of old grass lands being capable of affording a good produce for a time. The same consequences may likewise take place even upon soils of a much better quality, by such methods of cropping. It is evident that they should, therefore, be avoided as much as possible on all descriptions of soil by the correct agricultor. The last course not only displays the badness of the practice of taking successive grain crops, but that beans, by the aid of the hoeing culture, cannot afford a produce, even on newly broken up land, that will repay the trouble and expence of the cultivator.

ROTATION VII.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs.	4	2	0
2 Turnips	4 tons	0	16	0
3 Beans	5 qrs. 2 bushels	6	16	0
4 Potatoes	234 bushels	5	17	0
5 Beans	3 qrs.	4	2	0
6 Wheat	3 qrs. 4 bushels	7	10	0
		29	3	0
	Per annum	£. 4	17	6

ROTATION VIII.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 2 bushel	4	5	0
2 Cabbages	6 tons	1	10	0
3 Beans	3 qrs.	6	10	0
4 Cabbages	6½ tons	1	12	6
5 Beans	4 qrs. 2 bushels	5	12	0
6 Wheat	3 qrs. 6 bushels	8	0	0
		27	9	6
Per annum	£.	4	11	7

ROTATION IX.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs.	4	2	0
2 Potatoes	147 bushels	3	13	0
3 Beans	4 qrs.	5	6	0
4 Cabbages	6½ tons	1	12	6
5 Beans	4 qrs. 2 bushels	5	12	0
6 Wheat	3 qrs. 5 bushels	7	15	0
		28	0	6
Per annum	£.	4	13	5

The produce of the first of these courses, though there is only one grain crop in the six years, is, it is observed, so considerable as to shew the disadvantage of deteriorating rotations, especially as the circumstances under which they are put in, are supposed by some to be unfavourable, on account of the land, after turnips and potatoes, from the tillage which is required for such crops, being left in too light a state for the growth of beans. It has the advantage also of leaving the land perfectly clean, and in a fertile condition. And likewise proves, in the writer's opinion, that great attention may be had to the keeping of land clean, and in heart, by gentle modes of cropping, without the danger of immediate injury being sustained by it. It is further supposed that if beans or wheat had been the crop of the fourth year upon the manure in place of the potatoes, the profit on the whole would have been more, without the ground being left in a less rich condition.

The two last courses demonstrate, that from there being but one grain crop in six years, though cabbages, by being removed from the land, exhaust; three crops of beans are sufficient to preserve the land for a good wheat crop, besides leaving it in a good state. They are, therefore, profitable courses, and such as are suited to the obtaining of perfect cleanness of culture. In the latter course, the profit is, however, less, from the circumstance of potatoes being introduced.

ROTATION X.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs.	4	2	0
2 Beans	4 qrs.	5	6	0
3 Beans	4 qrs. 6 bushels	6	4	0
4 Cabbages	8½ tons	2	2	6
5 Beans	4 qrs.	5	6	0
6 Wheat	4 qrs. 1 bushel	8	15	0
		31	15	6
Per annum	£.	5	5	11

ROTATION XI.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs. 7 pecks	4	2	9
2 Barley	4 qrs. 7 bushels	5	7	6
3 Beans	4 qrs.	5	6	0
4 Barley	5 qrs. 4 bushels	7	0	0
5 Beans	4 qrs. 1 bushel	5	9	0
6 Wheat	3 qrs. 1 bushel	6	15	0
		34	0	3
	Per annum	£. 5	13	4

ROTATION XII.

Course.	Produce.	Value. £.	s.	d.
1 Beans	3 qrs.	4	2	0
2 Wheat	2 qrs. $6\frac{1}{2}$ bushels	6	2	6
3 Beans	3 qrs. $2\frac{1}{2}$ bushels	4	9	6
4 Wheat	3 qrs. $3\frac{1}{4}$ bushels	7	8	9
5 Beans	3 qrs.	4	2	0
6 Wheat	3 qrs.	6	10	0
		32	14	9
	Per annum	£. 5	9	1

It is evident, from the first of these courses, that successive crops of beans have a considerable ameliorating power, as both the cabbages and beans after them were very good. Their effects in preserving the fertility arising from the old turf is likewise obvious, as well as that of keeping the land perfectly free from weeds, at the same time that a good profit is afforded. It also affords a strong proof of the advantage of a careful method of cropping newly broken up lands.

Such courses should, consequently, be more frequently employed on all those stiff and retentive descriptions of land on which beans can be grown, both with the view of immediate profit, and the benefits that ensue from the land being kept clean.

The second course affords, in the writer's opinion, an example of a good and correct mode of practice, without much exhaustion, though, if compared with the preceding course, there appears to be a slight degree of deterioration from the wheat, in that being a quarter more. It may, however, be adopted as a very profitable rotation. The last of these courses is well known to be a very profitable one on the richer sorts of heavy soils; and it is here shewn to answer well on such as are of an inferior quality, even without the application of manure. The power of bean crops, in preserving the fertility of lands newly broken up from sward, is likewise evinced by the sixth crop, though inferior to others. This rotation should not, however, in general be attempted, except on the richest kinds of heavy soils.

ROTATION XIII.

Curſe.	Produce.	Value. £.	s.	d.
1 Turnips	3 tons	0	12	0
2 Ditto	5½ tons	1	2	0
3 Oats	9 qrs.	8	12	0
4 Potatoes	252 buſhels	6	6	0
5 Beans	3 qrs. 1 buſhel	4	5	0
6 Wheat	3 qrs. 3 buſhels	7	5	0
		28	2	0
Per annum		£. 4	13	8

ROTATION XIV.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	3 tons	0	12	0
2 Cabbages	6 tons	1	10	0
3 Oats	10 qrs. 5½ buſhels	10	2	4
4 Cabbages	8 tons	2	0	0
5 Beans	3 qrs. 5 buſhels	5	17	0
6 Wheat	3 qrs.	6	10	0
		26	11	4
Per annum		£. 4	8	6

ROTATION XV.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	3½ tons	0	14	0
2 Potatoes	154 buſhels	3	17	0
3 Oats	8 qrs. 5¼ buſhels	8	1	11
4 Cabbages	8 tons	2	0	0
5 Beans	3 qrs. 5 buſhels	4	17	0
6 Wheat	3 qrs. 1 buſhel	6	15	0
		26	4	11
Per annum		£. 4	7	6

The firſt of the above courſes exhibits the utility of repeated turnip crops in the preparation of this kind of ſoil for grain crops, the produce of the oats, from the pulveriſation they effected, being very great. It is obſerved that oats are moſtly ſown on newly broken up lands, but never with much ſucceſs on ſuch as are wet. The exhauſtion of the ſoil in this courſe ſeems not to have been great, though the oats were followed by potatoes, which are known to exhauſt, as the ſucceeding bean and wheat crops were both good, but more eſpecially the latter.

It is obvious, however, that as turnips and cabbages cannot be produced to advantage on ſuch cold wet ſoils without much manure, that ſuch rotations muſt be the moſt beneficial and proper on the drier ſorts of land, where ſuch crops can be grown and fed on the ground.

It is obſerved by the experimenter, that the groſs product in the ſecond courſe is not to be compared with the firſt, as the potatoes, affording ſix guineas,

left no profit. The largeneſs of the produce of oats ſeems to ſhew the beneficial effects of cabbage crops in preparing the ſoil. The inferiority of the wheat crop, when compared with that in the firſt of theſe rotations, is ſuppoſed to depend on the want of manure. Notwithſtanding there are two crops of cabbages and one of turnips in this courſe, it appears, the author ſays, to be profitable. It would ſeem, however, to be the moſt ſuited to the dry kinds of ſoils.

In comparing the third rotation with the two that precede it, the deteriorating properties of potatoes are evidently much greater than thoſe of either turnips or cabbages, from the inferiority of the oat crop that followed them. It is indeed ſuggeſted by the inſtitutor of the experiment, that "wherever potatoes inter with a ſmall produce, the expences more than abſorb the value."

ROTATION XVI.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	3 tons	0	12	0
2 Beans	4 qrs.	5	6	0
3 Oats	8 qrs. 7 buſhels	8	9	9
4 Cabbages	6 tons	1	10	0
5 Beans	3 qrs. 6 buſhels	5	0	0
6 Wheat	3 qrs. 2 buſhels	7	0	0
		27	17	9
Per annum		£. 4	12	11

ROTATION XVII.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	$5\frac{1}{2}$ tons	0	14	0
2 Barley	5 qrs. 1 peck	5	0	7
3 Oats	5 qrs. 5 buſhels	5	11	3
4 Barley	4 qrs.	4	10	0
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs.	4	10	0
		24	7	10
Per annum		£. 4	1	3

ROTATION XVIII.

Courſe.	Produce.	Value. £.	s.	d.
1 Turnips	3 tons	0	12	0
2 Wheat	2 qrs. 7 buſhels	6	5	0
3 Oats	4 qrs. $6\frac{1}{2}$ buſhels	4	16	1
4 Wheat	2 qrs. 3 buſh. $\frac{1}{2}$ peck	5	5	
5 Beans	2 qrs.	2	18	0
6 Wheat	1 qr. 7 buſhels	4	5	0
		24	1	5
Per annum		£. 4	0	2

The reſult of the firſt of the above courſes diſplays the advantage of beans over potatoes in reſpect to profit. In the ſecond rotation the land being left

foul and in bad condition, ſhews, by the lightneſs of the wheat crop, when compared with thoſe in other courſes, that great exhauſtion had been produced by it. The laſt rotation exhibits a ſtill worſe practice; and that the land is left in a more deteriorated and foul ſituation by three wheat crops. Such courſes can, therefore, never be had recourſe to with either the view of profit or that of keeping the land in order.

ROTATION XIX.

Courſe.	Produce.	Value. £. s. d.
1 Potatoes	106 buſhels	2 13 0
2 Turnips	4½ tons	0 18 0
3 Potatoes	136 buſhels	3 8 0
4 Potatoes	198 buſhels	4 19 0
5 Beans	2 qrs.	2 18 0
6 Wheat	1 qr. 6 buſhels	4 0 0
		18 16 0
	Per annum	£. 3 2 8

ROTATION XX.

Courſe.	Produce.	Value. £. s. d.
1 Potatoes	105 buſhels	2 12 6
2 Cabbages	5 tons	1 5 0
3 Potatoes	110 buſhels	2 15 0
4 Cabbages	4 tons	1 0 0
5 Beans	2 qrs. 2 buſhels	3 4 0
6 Wheat	2 qrs.	4 10 0
		15 6 6
	Per annum	£. 2 11 0

ROTATION XXI.

Courſe.	Produce.	Value. £. s. d.
1 Potatoes	104 buſhels	2 12 0
2 Ditto	126 buſhels	3 3 0
3 Ditto	97 buſhels	2 8 6
4 Cabbages	3 tons	0 15 0
5 Beans	1 qr. 7 buſhels	2 15 0
6 Wheat	1 qr. 4 buſhels	3 10 0
		15 3 6
	Per annum	£. 2 10 7

By theſe courſes, the deteriorating effects of potatoe crops are fully demonſtrated. With manure, in the proportion already explained in the fourth crop, the beans which ſucceeded were a very poor produce; and the wheat, though the only white crop in ſix years, is ſtated to be a "miſerable produce in a very good year." It is obſerved that in the fourth courſe, where there were two

crops of wheat, with three of beans, the concluding wheat crop afforded three quarters one buſhel without any manure; a difference that is highly ſtriking. And that in the eighth, three crops of beans, and two of cabbages, were followed with very good wheat, though cabbages removed from the ground exhauſt; but in theſe courſes there are ſcarcely any, except ſucceſſive wheat crops, that exhauſt the land ſo greatly as potatoe crops.

The ſecond courſe diſplays little elſe, in the writer's opinion, than a continued loſs; and the third affords a proof of the loweſt decreaſe of produce that can be ſuppoſed on newly broken up land; beſides, the ſoil left ſo foul and deteriorated, that the whole of its fertility, from improvement, and the decay of the old turf, appears removed. It makes ſtrongly againſt potatoes, which can probably only be introduced with advantage as a cleaning crop, and where manure is plentiful.

ROTATION XXII.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 buſhels	2	10	0
2 Beans	3 qrs.	4	2	0
3 Potatoes	142 buſhels	3	11	0
4 Barley	5 tons	1	5	0
5 Beans	2 qrs. 3 buſhels	3	10	0
6 Wheat	2 qrs. 1 buſhel	4	15	0
		19	13	0
Per annum		£. 3	5	6

ROTATION XXIII.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	101 buſhels	2	10	6
2 Barley	4 qrs. 7 buſhels	5	7	6
3 Potatoes	127 buſhels	3	3	6
4 Barley	3 qrs. 2 buſhels	3	15	0
5 Beans	2 qrs. 7 buſhels	3	19	0
6 Whea	2 qrs. 5 buſhels	5	15	0
		24	10	6
Per annum		£. 4	1	9

ROTATION XXIV.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 buſhels	2	10	0
2 Wheat	2 qrs. 1 buſhel	4	15	0
3 Potatoes	104 buſhels	2	12	0
4 Wheat	2 qrs.	4	10	0
5 Beans	2 qrs. 2 buſhels	3	4	0
6 Wheat	1 qr. 6 buſhels	4	0	0
		21	11	5
Per annum		£. 3	11	10

By the firſt of theſe courſes the exhauſting effects of potatoes is rendered ſtill more evident, but the effects of the beans are ſomewhat different.

From the ſecond it is clear that barley ſucceeds better after potatoes than wheat, while the inferiority of the ſecond crop proves that the preparation they afford is not perfectly ſuitable, and that the wheat that ſucceeds is affected by their deteriorating property. The third courſe, beſides confirming different reſults that have been ſtated, affords, by a compariſon with the twelfth, proofs of the utility of alternating beans and wheat.

ROTATION XXV.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	98 buſhels	2	9	0
2 Turnips	4 tons	0	16	0
3 Cabbages	5½ tons	1	7	6
4 Potatoes	270 buſhels	6	15	0
5 Beans	2 qrs. 2 buſhels	3	4	0
6 Wheat	2 qrs. 2 buſhels	5	0	0
		19	11	6
Per annum		£. 3	5	3

ROTATION XXVI.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	101 buſhels	2	10	6
2 Cabbages	6 tons	1	10	0
3 Cabbages	5½ tons	1	7	6
4 Cabbages	3 tons	0	15	0
5 Beans	2 qrs. 6 buſhels	3	16	0
6 Wheat	2 qrs. 2 buſhels	5	0	0
		14	19	0
Per annum		£. 2	9	10

ROTATION XXVII.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 buſhels	2	10	0
2 Potatoes	115 buſhels	2	17	6
3 Cabbages	3½ tons	0	17	6
4 Cabbages	3½ tons	0	17	6
5 Beans	2 qrs. 2 buſhels	3	4	0
6 Wheat	2 qrs.	4	10	0
		14	16	6
Per annum		£. 2	9	5

In the firſt of the above courſes, though the potatoes of the fourth crop were manured for as has been explained, the poorneſs of the wheat crop, which was the only one of the grain kind in ſix years, proves, it is ſuppoſed, the exhauſting effects of cabbage and turnip crops, when removed from the ground, in combination with potatoes, to be conſiderable; and from the ſecond it is evident that cabbages, when not conſumed upon the ſoil, are ſo prejudicial as not

to permit the ameliorating powers of beans to ſecure a favourable crop of wheat. Neither this nor the preceding courſe is, therefore, profitable. The laſt is obſerved to be a rotation of nothing but loſs, and which further ſhews the exhauſting effects of potatoes and cabbages, when removed from the ground, to be very conſiderable.

ROTATION XXVIII.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	96 buſhels	2	8	0
2 Beans	3 qrs. ½ peck	4	2	4
3 Cabbages	6½ tons	1	12	6
4 Cabbages	4 tons	1	0	0
5 Beans	2 qrs. 2 buſhels	3	4	0
6 Wheat	2 qrs. 3 buſhels	5	5	0
		17	11	10
Per annum		£. 2	18	7

ROTATION XXIX.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 buſhels	2	10	0
2 Barley	4 qrs. 7½ buſhels	5	8	9
3 Cabbages	4 tons	1	0	0
4 Barley	4 qrs. 1 buſhel	4	12	6
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs. 6 buſhels	6	0	0
		23	13	3
Per annum		£. 3	18	10

ROTATION XXX.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	99 buſhels	2	9	6
2 Wheat	2 qrs. 7 buſhels	6	5	0
3 Cabbages	4½ tons	1	2	6
4 Wheat	3 qrs. 6 buſh. 1½ pks.	8	1	6
5 Beans	2 qrs. 6 buſhels	3	16	0
6 Wheat	2 qrs.	4	10	0
		26	4	6
Per annum		£. 4	7	5

It is obſerved that the rotations in which potatoes and cabbages not conſumed on the land enter in any conſiderable degree, all ſhew the ſame thing; which is, that, under particular circumſtances, they are both prejudicial in exhauſting the ſoil.

The two latter of the above courſes, when compared with thoſe of eleven and twelve, diſplay the advantages of beans over potatoes and cabbages in a very ſtriking manner.

ROTATION XXXI.

Course.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bushels	2	10	0
2 Turnips	4 tons	0	16	0
3 Turnips	5 tons	1	0	0
4 Potatoes	288 bushels	7	4	0
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs. 7 bushels	6	5	0
		21	17	0
Per annum		£. 3	12	10

ROTATION XXXII.

Course.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bushels	2	10	6
2 Cabbages	5 tons	1	5	0
3 Turnips	4 tons	0	16	0
4 Cabbages	4 tons	1	0	0
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs. 6 bushels	6	0	0
		15	13	6
Per annum		£. 2	12	3

ROTATION XXXIII.

Course.	Produce.	Value. £.	s.	d.
1 Potatoes	100 bushels	2	10	0
2 Potatoes	112 bushels	2	16	0
3 Turnips	4 tons	0	16	0
4 Cabbages	4½ tons	1	2	6
5 Beans	2 qrs. 5 bushels	3	13	0
6 Wheat	1 qr. 3 bushels	5	5	0
		16	2	6
Per annum		£. 2	13	9

The profit of the first of these courses is too trifling to recommend it; and the products of the fifth and sixth years' crops are suggested to be less than they ought to be, from the circumstance of manure being applied in the fourth, and there being only one grain crop in the course. Therefore potatoes, even when manured for, leave the soil in no very advantageous situation for the growth of wheat, though assisted by the cleaning and improving qualities of beans.

The second and third courses are equally decisive in shewing the exhausting effects both of potatoe and cabbage crops, when not consumed on the land, and that they are courses that should seldom be employed where they cannot be manured for and fed off upon the ground.

ROTATION XXXIV.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	98 buſhels	2	9	0
2 Beans	3 qrs. 1 peck	4	2	9
3 Turnips	4 tons	0	16	0
4 Cabbages	5½ tons	1	7	6
5 Beans	3 qrs.	4	2	0
6 Wheat	2 qrs. 6 buſhels	6	0	0
		18	17	3
	Per annum	£. 3	2	10

ROTATION XXXV.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 buſhels	2	10	0
2 Barley	4 qrs. 6 buſh. 3 pks.	5	6	10
3 Turnips	4 tons	0	16	0
4 Barley	4 qrs.	4	10	0
5 Beans	3 qrs.	4	2	0
6 Wheat	3 qrs.	6	10	0
		23	14	10
	Per annum	£. 3	19	1

ROTATION XXXVI.

Courſe.	Produce.	Value. £.	s.	d.
1 Potatoes	100 buſhels	2	10	0
2 Wheat	2 qrs. 6 buſhels	6	0	0
3 Turnips	4 tons	0	16	0
4 Wheat	2 qrs. 7 buſh. 2½ pks.	6	8	0
5 Beans	2 qrs. 6 buſhels	3	16	0
6 Wheat	2 qrs. 6 buſhels	6	0	0
		25	10	0
	Per annum	£. 4	5	0

The firſt of the above rotations exhibits the effects of potatoes and cabbages ſtill further. The ſecond courſe alſo ſhews, that while the turf of newly broke up ſoils is in a ſtate of decay, ſpring corn ſucceeds well after potatoe crops. It likewiſe proves, that three grain crops may be grown in ſix years without the ſoil being greatly exhauſted, when proper attention is paid to the nature of the intervening crops.

The injurious conſequences of cropping land with grain, and other ſorts of crops, that exhauſt in a high degree, may probably be prevented in the beſt manner on the more ſtiff and retentive ſorts of land, whether of the clayey or loamy kinds, by the interpoſing of bean and clover, or tare crops, between them, as the experiments detailed above have ſhewn the former to poſſeſs the power of ameliorating the condition of ſuch ſoils; and the latter ſeems not leſs calculated for the ſame purpoſe, as it is known to grow well on theſe ſorts of land: and on thoſe of a more light and dry quality, whether ſandy

or of a gravelly nature, the intermixing of turnip, pea, and other crops of the ſame ſort, with thoſe of corn, may be equally ſucceſsful. In many caſes, eſpecially on the more heavy kinds of ſoil, it may be neceſſary and highly beneficial to take two green crops for one of grain. This is a practice, that the reſults of the trials juſt detailed place in an advantageous point of view, and which has extended itſelf over a conſiderable tract of land with great ſucceſs in the county of Middleſex; and by which, from the cleanneſs of the cultivation, and the great vigour of the land, in conſequence of the few corn crops, the grain is found of a ſuperior quality. It is indeed remarked by a writer of conſiderable experience, that land under common circumſtances will not even bear, without injury, a corn crop every two years. This is fully ſhewn, he conceives, by the turnip crops in Norfolk being uniformly found to be not only leſs certain, but much lighter than formerly, as well as from the ſame remark being applicable to the clover, and probably to the corn crops. Such diminutions in the quantity of produce, he ſuppoſes, demonſtrate that the valuable and favourite rotation of that diſtrict, as turnips, barley, clover, wheat, is ſomewhat more than the ground can ſuſtain, as it appears to be gradually ſinking under too much exhauſtion. With the aid of extenſive ſheep-walks, he thinks the ſoil not even able to ſupport the depreſſion of the preſent courſe of crops, eſpecially when a five-years' courſe, by introducing barley after wheat, is injudiciouſly had recourſe to *.

On incloſed lands, of different kinds, the ſame author recommends the following courſes as the moſt proper: For the beſt ſorts of land, alternate green and white crops; for ſuch as are of a full medium quality, three green crops for two of the grain or white kind; for ordinary land, two green for one of the corn ſort; and for the worſt, or that which is the moſt exhauſted, as downs and ſheep-walks, three green crops to one of the white or grain kind.

Cropping in theſe methods and proportions would, it is ſuppoſed, keep the lands perfectly free from weeds, and in a ſtate of high culture, and, "*under ſuch management, might be continued in perpetual aration, with a conſtant ſucceſſion of large products* †." Beſides, the farmer, it is imagined, by adopting ſuch a ſyſtem, would not be idly flattered "by a *promiſing ſeed-time*, and miſerably diſappointed by a *ſcanty harveſt*, as is frequently the caſe; but, on the contrary, be ſure (at leaſt as far as depends on human means) of reaping a plentiful return for all his labour and expence."

* Middleton's Report of the Agriculture of Middleſex, p. 158. † Ibid.

Various arrangements of crops, comprehending different numbers of the green kind to thoſe of grain, may be formed. The following are judicioufly recommended by Mr. Middleton, and are in the proportions of from two to five of the former, to one of the latter:

1ſt. Two green crops to one of corn.

Corn; (or) Peas;
Clover; Beans;
Peas: Corn.

2d. Three green crops to one of corn.

Corn; (or) Corn;
Clover; Clover;
Tares; Peas;
Turnips: Beans.

Which is four crops in three years.

3d. Four green crops to one of corn.

Tares;
Potatoes, or cole, for ſheep feed;
Turnips;
Corn;
Clover.

Making five crops in four years.

4th. Five green crops to one of corn.

Peas;
Beans;
Corn;
Clover;
Tares;
Turnips.

Making ſix crops in five years.

By inculcating and adopting ſuch methods of cropping as the above, the danger of exhauſting the fertility of the ſoil will not only be completely prevented, but the injurious conſequences of weeds be guarded againſt, which cannot be the caſe where repeated grain crops are grown in ſucceſſion, as the experiments detailed above ſufficiently prove, and which are ſtill further confirmed by the reports of different counties, that have been lately publiſhed under the directions of the Board of Agriculture.

The following has been ſuggeſted as a courſe well adapted to *newly* broken up lands, of the heavier and more wet kinds, from the profit of beans being conſiderable in all caſes where the ſoil has not been exhauſted, and from the circumſtance of oats being a much more productive crop than either barley or wheat, while the graſſy material of the old ſward is in a ſtate of decay, as is fully demonſtrated in the preceding details. The clover reſtoring the diminiſhed fertility cauſed by the alternate bean and oat crop, which the beans in the eighth year would have no tendency to leſſen, while the wheat, after two ſuch ameliorating crops, could ſcarcely avoid being an abundant crop: 1, beans; 2, oats; 3, beans; 4, oats; 5, beans; 6, oats; 7, clover; 8, beans; 9, wheat*.

* Young's Annals of Agriculture, vol. XXIII.

It is evident, however, that ſuch repeated cropping with grain crops, although ameliorating ones may be interpoſed, muſt ſoon conſiderably reduce the fertility of the land, and of courſe can only be had recourſe to while there is a large portion of vegetable matter undergoing decompoſition in the ſoil.

And it is recommended as an improvement in the cropping of unincloſed lands, where, from the circumſtance of turnip and clover crops not being capable of being much grown, no perfect ſyſtem of huſbandry can be purſued, to adopt the following courſe: firſt year, barley; ſecond year, clover, on as much as manure can be applied over to preſerve the plants from ſuſtaining injury by the cloſeneſs of the bite of ſheep; the remainder in peas in the drill method, which ſhould be twice hoed, being earthed up at the latter operation; third year, wheat; fourth, potatoes, or ſpring tares. When potatoes, they ſhould be planted at ſo early a period, as that they may admit of being taken up about the time cattle are to be turned in *. Where the ſoil is good, and ſufficiently light, the early ſort might probably be the moſt proper in ſuch caſes, eſpecially in ſituations near large towns, where there is great demand for them.

It has been found, by the experience of different cultivators, that ſuch lands as have had their fertility greatly reduced by injudicious modes of cropping with grain in too frequent ſucceſſion, and which are thereby become foul, and in a bad condition, may often be reſtored by cropping for three or four years in ſuch courſes as that what are termed green crops may enter in very large proportion with more profit, and as little difficulty, as by being laid to the ſtate of paſture. In this view the crops may be clover for two years; then cole, tares, or turnips, the land being previouſly manured; afterwards beans or peas, the crops being kept perfectly clean by repeated hoeing; and laſtly barley, or in ſome caſes, perhaps, wheat, with ſuch graſs ſeeds as may be adapted to the nature of the ſoil. That this may be accompliſhed with great advantage in this way, there can ſcarcely be a doubt; ſince it has been proved by the experience of the moſt correct agricultors, that any determinate quantity of land when cropped with clover, tares, turnips, or other ſimilar crops, will produce twice as much food as when in the ſtate of graſs †.

In the common methods of cropping, on ſtrong, wet, clayey, or ſtiff loamy ſoils, where it appears probable, as has been already ſeen, that the practice of a naked fallow may ſometimes be required, it is the moſt improved

* Middleton's Report of Middleſex.

† Cartwright, in Communications to the Board of Agriculture, vol. III.

cuſtom to make it the preparation for the firſt grain crop, depending upon ſome ſort of green one for thoſe that follow, without repeating it; as in this way: 1, fallow; 2, barley; 3, clover; 4, wheat. Or where manure is in abundance, a preferable courſe in ſuch caſes may be: 1, fallow; 2, wheat; 3, beans; 4, barley; 5, clover; 6, wheat. But even on this deſcription of ſoils it may be more advantageous to crop in this manner: 1, cabbages, beans, or peas; 2, barley or oats; 3, clover; 4, wheat: or 1, cabbages; 2, oats; 3, beans; 4, wheat: or to begin with 1, beans; 2, wheat; 3, cabbages; 4, barley; 5, clover; 6, wheat. And even in particular caſes, where there is good culture; 1, turnips; 2, oats; 3, yetches; 4, wheat.

In breaking up theſe ſoils from graſs by paring and burning, the courſe may be: 1, cole; 2, beans; 3, wheat; 4, beans; 5, wheat. Tares, though properly objected to by ſome cultivators, as coming too late in the ſpring on ſuch ſoils, may ſometimes be beneficially introduced for the purpoſe of being eaten off by ſheep, or mown green for horſes, milch cows, young ſtock, and hogs*. By theſe modes of cropping, with proper attention to the eating the green crops off, where it can be done without injury, or the removing of them to be conſumed in the farm-yards, or other places, in order to the manure being afterwards applied, the land may not only be improved by being rendered more friable, rich, and mellow, but be kept clean and free from weeds.

But on the richer deſcriptions of loamy ſoils, as well as thoſe of the ſandy kind, it ſeems to be the practice of the moſt improved arable diſtricts to make turnips the preparation for the barley crop, and clover that for wheat, in this way: 1, turnips; 2, barley; 3, clover; 4, wheat. In this courſe oats may ſometimes be ſubſtituted for the barley; and, inſtead of the clover, tares, chicory, or ſome other ſort of artificial graſs ſeeds. When ſoils of this kind are broken up from the ſtate of graſs, and the proceſs of paring and burning adopted, the courſe ſhould be: 1, turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley; 7, clover; 8, wheat; 9, turnips; 10, barley. If the ground is to be kept in tillage only a ſhort time, the moſt proper courſe may be: 1, turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley; with graſs ſeeds.

But where the practice of paring and burning is not adopted, which is by

* Cartwright, in Communications to the Board of Agriculture, vol. III.

no means ſo common, it may be the beſt method to begin by beans or peas dibbled, and then proceed in the ſame manner as above. In theſe caſes the turnip and clover crops are always to be eaten off by ſheep, or ſome other kind of ſtock.

In the more dry and light kinds of ſoils of this nature, pea crops may be introduced, eſpecially thoſe of the white ſort dibbled as a firſt crop, then proceeding with the other crops in the above manner. Where potatoes are begun with, more of the repleniſhing crops will be required, on account of their greater deteriorating qualities.

On the merely ſandy ſoils, in ſome diſtricts, turnips are made the preparation for graſs, as well as grain: and it is found that there are none of theſe ſoils ſo light, as that they will not afford ſuch a crop. The courſe is commonly, 1, turnips; 2, barley; 3, graſs ſeeds. The graſſes in theſe caſes are to be cultivated with a view to the feeding of ſheep, conſequently ſhould be ſuch as will ſtand for ſome length of time, as it is by no means a good practice to break up again too ſoon; the flocks fed upon the turnips during the winter ſeaſon not being provided with a due quantity of food on ſuch *new* layers for their ſummer ſupport.

It is remarked that in Suffolk, on the better lands of this ſort, the layers are often planted with peas, by dibbling, to much advantage, after being broken up, without being fed with ſheep in the ſummer. The ſucceeding crop of wheat being in ſuch methods much larger, the following courſe is ſaid to be an excellent one for ſuch ſoils: 1, turnips; 2, barley; 3, trefoil and ray graſs; 4, peas dibbled; 5, barley *.

Where ſoils of this ſort are poor, or partake of the nature of heaths or ſheep walks, it may be the beſt practice, in bringing them into arable cultivation, to, 1, pare and burn for turnips; 2, turnips; 3, barley, with graſs ſeeds. If they are intended to be kept under the plough longer than this courſe, the turnip and barley, and graſs crops, may be alternately repeated until the fifth or ſeventh year, or even longer, if it be thought neceſſary.

And as we have ſeen that potatoes exhauſt in a conſiderable degree, where they are adopted as the firſt crop; in breaking up ſuch ſoils, they muſt be ſucceeded by ameliorating crops, ſuch as turnips and graſs, as in the preceding courſes †. Where theſe ſoils are poor, and of the light blowing kind, their

* Young's Report of the County of Suffolk.

† Communications to the Board of Agriculture, vol. III. p. 136.

tenacity muſt be increaſed by the application of clay in ſuitable proportions, and the reeding off the crops by ſheep. But where theſe means cannot be adopted, the courſe recommended above will be the moſt proper.

The gravelly and flinty ſoils, when of the lighter kinds, ſhould be cropped in ſuch a manner as may be the moſt effectual in preventing their moiſture from being diſſipated, and their fertility from being impaired. In theſe views two or more green crops may often be neceſſary for one of grain in the way that has been deſcribed above; or 1, turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley, with graſs ſeeds. Peaſe, tares, and cole, may alſo be introduced with great propriety in courſes for theſe ſoils. Where flints abound, as hoeing cannot be practiſed with facility, it has been recommended by an experienced cultivator to ſow the turnips thinly, and mix a portion of cole-ſeed with them, by which means an abundance of ſheep food may be produced *. The grain crops, eſpecially thoſe of the ſpring kind, ſhould always on ſuch ſorts of ſoil, where ſufficiently dry, be ſown early, that they may cover the ground well before the hot ſeaſon commences.

On the heavier deſcriptions of theſe ſoils, beans or peas may, however, frequently be made the preparatory crops for barley, or even wheat, in this way: 1, beans or peas; 2, barley; 3, clover; 4, wheat; and which may be ſtill further varied by tares and turnips, according to the particular ſtate of the land.

On the thinner kinds of chalky ſoils, and ſuch old down lands as are become ſo unproductive of herbage as not to be capable of being continued in the ſtate of ſheep paſture, it may be the moſt advantageous method of cropping when brought into tillage to make turnips or ſome other luxuriant green crop, which, while it keeps the land clean, and produces a large proportion of green food for the ſupport of ſheep or other animals, is beneficial by preſerving the moiſture, which in ſuch ſorts of ſoil is liable to be diſſipated too quickly, the preparation for grain. In theſe intentions the courſe may be, 1, turnips; 2, barley; 3, clover; 4, wheat; or in ſome caſes, as where ſeed weeds are liable to prevail much, two crops of turnips may be taken before any grain crop with utility and advantage. If it be intended to keep ſuch lands longer in the ſtate of tillage, two crops of turnips may be again grown after the wheat, which will leave the ſoil in a high ſtate of preparation for barley, then ſaintfoin may be introduced, as affording an excellent paſture for ſheep for ſeveral years. In theſe caſes the turnip and clover crops muſt conſtantly be fed off by ſheep, which ſhould not be removed from the land during the whole of the time the crops are in con-

* Boys in Communications to the Board of Agriculture, vol. III.

ſumption, ſuch other kinds of dry food as may be neceſſary being conveyed to them. By theſe means the ſoil will be left in the beſt poſſible ſtate for the growing of barley, without the trouble and expence that muſt otherwiſe be incurred for manure.

In ſome inſtances, as where the land is ſufficiently mellow and friable, the mode of cropping may be, 1, peas; 2, oats; 3, turnips; 4, barley, with graſs ſeeds; or if it be the intention of the cultivator to continue the courſe, he may proceed with turnips or peas as before, cloſing the rotation with ſaintfoin, as affording a paſture for ſheep for ſeveral years. By attention in cropping and managing lands of this nature, in the manner that has been juſt deſcribed, great improvements may be made, not only in rendering them capable of affording valuable grain crops, but as producing a much larger proportion of green food for the uſe of ſheep and other animals.

In the cropping of peaty, moory, and fenny ſoils, after draining them of their injurious moiſture, ſome difference muſt be made according as they are deep, or only poſſeſs a ſlight covering of the peaty matter. Where they are of the deeper kinds, it may be the moſt judicious practice to make turnips, potatoes, cabbages, cole, or ſuch ſorts of crops as produce much ſhade, and by preſerving the moiſture in the more ſuperficial parts of the ſoil, promote its decompoſition and decay, the preparation for grain. In this view the crops may be, 1, turnips, cabbages or cole; 2, oats; 3, turnips, cabbages or cole, as before; 4, oats; 5, clover; 6, wheat; 7, turnips, &c. as above; 8, oats, with graſs ſeeds.

From the great exhauſting property of potatoe crops, they have been objected to by ſome agricultors; but on ſoils of this kind, experience ſeems to ſhew them to be highly uſeful. When they are employed the courſe may be, 1, potatoes; 2, oats; 3, turnips, cole or cabbage; 4, the ſame; 5, oats, with graſs ſeeds. In the northern parts of Scotland, on ſoils of this kind, the employing of potatoes as a firſt crop has been found to be by much the moſt certain and advantageous mode, the ſucceeding crops of oats being not only more certain, but greatly more abundant *.

But on the thinner deſcriptions of theſe ſoils, as thoſe of a moory and fenny nature, and where the ſubſoil is of the ſtiff and retentive kind, it may be the moſt proper practice to begin with cole, and make it the preparation for grain crops in this way; 1, cole; 2, oats; 3, cole; 4, oats; or, 1, cole; 2, oats; 3, beans with dung; 4, potatoes; 5, wheat; 6, cole; 7, oats. But in this laſt method,

* Modern Agriculture, vol. IV. p. 65.

as it is probable that by potatoes and wheat coming together there may be danger of the land being too much exhauſted, it may be better to omit the potatoes and introduce beans in their ſtead, which we have ſeen to be an improving crop, in this way: 1, cole; 2, oats, the land being dunged; 3, beans; 4, wheat; 5, cole; 6, oats. It would ſeem alſo that on ſome of theſe ſoils clover might be introduced with advantage as a preparation for the wheat crops. It is a matter of great conſequence on ſuch ſoils as theſe to have recourſe to judicious modes of cropping, as the improvements made on lands of this kind by ſuch means are, in general, much greater than in other caſes.

In almoſt all the heavier ſorts of land, where they are broken up from the ſtate of old ſward, it will be found that beans are by much the beſt crop to begin with, though oats are moſtly ſown, as the decay of the turfy or graſſy matter is ſo favourable to their growth, that they ſeldom fail in ſuch caſes of affording an abundant crop. Beſides, the bean crops in this way contribute to render the ſucceeding tillage more effectual, by the roots penetrating ſo deeply into the ſoil, and thus in many inſtances become an excellent preparation for wheat. On the lighter ſorts of ſoil, peas might likewiſe in many caſes be the moſt advantageous crop to begin with. And as in lands that have remained a great length of time in the ſtate of ſward, there may be danger of the firſt crops, after their being broken up, being injured by the ravages of worms and grubs, which are often found to exiſt in great abundance in them, it may be adviſable, where they are much ſuſpected, to adopt the practice of paring and burning, or of turning the graſſy ſurface completely under, to ſome depth, by means of the trench-plough. The former is, however, by much the beſt practice, though the latter may be highly uſeful where the graſs is coarſe and cannot be eaſily removed *. But where neither of theſe methods is thought adviſable, as beans are not ſo liable to be attacked, it may be proper to repeat them. It has alſo been ſuggeſted, that advantage may be gained in this view, by keeping ſuch graſs lands as are to be brought into tillage, as bare and cloſely fed by ſheep and other animals as poſſible during the latter ſummer months, as by that means the fly may not be ſo much invited to depoſit its ova, as where the graſs is left of greater length †.

Where the nature of the farm admits of the ground being cultivated under the alternate ſyſtem of graſs and corn, or in what is moſtly termed convertible

* Dr. Wilkinſon, in Communications to the Board of Agriculture, vol. III. p. 240.

† Reverend Mr. Young, ibid. 133.

huſbandry, which, when every circumſtance is fully conſidered, is certainly a very advantageous method, it will be neceſſary in directing the courſe of crops not only to have regard to the particular quality of the land, but to the growing of ſuch ſorts of roots, plants, or other productions, as may, while they contribute to clean, improve, and prepare the ſoil for the production of abundant graſs crops, be the beſt adapted to the feeding, rearing, and maintaining of thoſe kinds of live ſtock that are to be kept, and that may afford the moſt abundant and regular ſupplies at the different ſeaſons when they are moſt wanted.

In this way the loamy, as well as the gravelly, fenny, and the thinner kinds of peaty ſoils, may be managed to great profit; as by their having many of the green crops fed off upon the land, much amelioration and improvement muſt be produced while in the ſtate of tillage, that muſt be favourable for the production of graſs, and by being occaſionally laid to graſs for a few years, and then thickly ſtocked with ſheep or other animals, they muſt undergo an excellent preparation for being again brought into tillage.

This ſort of huſbandry appears to be practiſed with great advantage in Northumberland, it having been found that, on the ſandy and dry light loamy ſoils, excellent grain crops, eſpecially oats, may be grown by the lands' remaining three years under graſs, cloſely eaten with ſheep, which could never be done while they were managed according to their old method of practice *.

Under this alternate ſyſtem of huſbandry, on the wetter and more ſtiff kinds of loamy ſoil, and where there is conſiderable fertility, the courſe may be, after breaking up, 1, beans or oats; 2, turnips; 3, barley; 4, clover, and ſometimes winter tares, according to circumſtances; 5, wheat; 6, turnip; 7, barley; 8, graſs ſeeds, to remain in the ſtate of paſture for three, four, or more years, as may be found the moſt ſuitable; or break up for, 1, oats; 2, beans; 3, wheat; 4, fallow and graſs for four or five years. But on thoſe of the drier deſcription, it may be more beneficial to begin with, 1, peas or turnips; 2, barley; 3, clover; 4, wheat; 5, turnips; 6, barley, with graſs ſeeds, to continue in the ſtate of paſture for not leſs than three years; or, in ſome caſes, the cultivator may begin with oats, then turnips, and afterwards barley with ſeeds, to remain in the ſtate of graſs for three or more years. It may likewiſe be uſeful where much green food is required, or there is an apprehenſion of danger from the wire-worm or grubs, to begin with turnips or cabbages, as ſuch crops moſtly ſucceed well in ſuch caſes when the turf is well

* Bailey and Culley's corrected Agricultural Report.

reduced and broken down by repeated harrowing, though not brought to a fine ſtate of mold *.

In a well-cultivated diſtrict in the northern part of the kingdom, different modes of cropping are ſaid to have been attempted in this view; and that of 1, turnips; 2, barley; 3, clover; 4, wheat, has been tried till there has been an evident falling off in the crops, eſpecially in thoſe of the green kind; the only means of recovering the lands in ſuch caſes being that of letting them remain, after their being three years under the plough, an equal length of time in the ſtate of graſs; "by this mode," it is obſerved, "nature has time to prepare a ſufficient *lea clod*, which, being turned up for the turnip fallow, will inſure a vigorous crop of turnips, as it is well known they always flouriſh upon freſh land, or where they find the remains of a *lea clod* to vegetate in †." And it is added, that the portion of ground "that is kept in graſs for three years, breeds and fattens ſuch a number of ſheep, as leave a conſiderable profit, probably equal to, if not more than, the arable crops ‡."

Theſe, as well as many other facts of the ſame kind, ſhew, in the moſt clear manner, the great benefits that may be derived from the cultivating of lands under the convertible method of farming. But in order that the agricultor may draw from it the greateſt poſſible advantage, he ſhould be well acquainted with the nature and management of different ſorts of live ſtock, with the beſt means of combining them with arable cultivation, and the moſt ready and convenient methods of breeding, rearing, and fattening them, under ſuch a connected ſyſtem of huſbandry.

It has been ſuggeſted to the cultivators of the lighter and more friable kinds of ſoils, or ſuch as are proper for the growing of barley, that where the keeping of live ſtock is the principal object, the following crops, in nearly the order

* Reverend Mr. Young, in Communications to the Board of Agriculture, vol. III.

† Bailey and Culley's corrected Report of the County of Northumberland.

‡ It is ſtated by the ſame writers that the yearly profit of a ſheep is eſtimated at not leſs than from twenty to thirty ſhillings; ſix or eight of which are fattened on an acre of clover, and on an acre of turnips double the number. By this ſyſtem, it is ſuppoſed, the principal advantages of folding are obtained without any of its inconveniences: for if upon an average

The firſt year's clover and graſs carry 7 ſheep an acre for 20 weeks,

2	- - - - -	5	- - 20,
3	- - - - -	3	- - 20,
And the turnips	- - -	12	- - 20;
That is	- - - -	27	ſheep per acre for 20 weeks: which is after the

rate of 540 per acre for one week, once in ſix years, leaving twenty-five ſhillings a-head profit.

in which they ſtand, may be capable of ſupplying a continued ſucceſſion of green food, of the beſt quality, in abundance all the year round: namely; water-meadows—rye-graſs—rye, cut green—winter tares—clover, the firſt crop—ſpring tares—clover, the ſecond crop—after-graſs of meadows; clovers and ſeeds of all ſorts—turnips—cabbages—potatoes—cole—Swediſh turnips—turnip-rooted cabbage.

"Whoever," ſays the intelligent writer, "will attend to the raiſing of the foregoing crops, on a ſcale proportioned to the ſize of his farm and the number of his *live ſtock*, need not be ſtraitened from want of food for *them* at any time or ſeaſon of the year. It is evident," he thinks, "on a bare inſpection of the liſt, that, conſidering the properties of the different plants, and the ſeaſons when each of them is the moſt fit for uſe, they complete the circle of the year. It may," ſays he, "perhaps be ſtarted as an objection, that many farms are without water-meadow:—very true; but then cole, Swediſh turnip, and turnip-rooted cabbage, might be produced in ſuch quantity as to be ſufficient for conſumption in March and April, during which months, and part of May, they are in the higheſt ſtate of perfection. Theſe might be aſſiſted, or even ſuperſeded, by turnips, potatoes, carrots, parſnips, and even cabbages, all of which being gathered while in the greateſt perfection, might be laid up in ſtore-pies, both with or without froſt or ſnow, for ſpring uſe. Water-meadows," continues he, "afford a vaſt deal of food from the middle of March; rye-graſs from the 1ſt of April; rye from the beginning of May; winter-tares ſoon follow; then comes clover, the firſt crop; ſpring tares; clover, the ſecond crop; and the after-graſs of natural meadows, clover, &c.; which will continue in perfection for heavy cattle till early ſown turnips are ready. Later ſown turnips and cabbages will be ſufficient till the end of February, without ſtoring; about which time the cole, Swediſh turnip, and turnip-rooted cabbage, will come in, and continue good through March and April, and even May, if needful *."

Where lands are to be reſtored to the ſtate of graſs after ſome time, if the hoeing ſyſtem be practiſed in ſuch a manner as that the different crops may be kept in a perfectly clean condition; and where the green kinds, ſuch as thoſe of turnips, peaſe, and beans, are put in on three-feet ridges, in double rows, and thoſe of the cabbage ſort on ſimilar ridges, but in ſingle rows; the following rotations have been ſuggeſted, by an experienced cultivator †, as the moſt ſuited for any length of time to different ſorts of ſoil.

* Middleton's Report of the Agriculture of Middleſex.

† Cloſe, in Communications to the Board of Agriculture, vol. III.

Clay - -	Turnips or Cabbages	Oats	Beans and Clover	Wheat	Turnips or Cabbages	Oats	Beans and Vetches	Wheat
Clayey loams - -	Turnips or Cabbages	Oats	Clover	Wheat	Turnips or Cabbages	Barley	Beans	Wheat
Rich loams, or Sandy loams -	Turnips and Potatoes	Barley	Clover	Wheat	Beans	Barley	Peaſe	Wheat
	Beans	Barley	Peaſe	Wheat	For any length of time			
	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	Wheat
Peat earth - - -	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	Wheat
Chalky ſubſtratum	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	Wheat
					but on this ſoil ten acres in every hundred ſhould be laid with ſaintfoin for 8 or 10 years.			
Gravels - -	Turnips	Barley	Clover	Wheat	Potatoes	Barley	Peaſe	
Light lands - -	Turnips	Barley	Clover & Rye-graſs	Clover & Rye-graſs	Clover and Rye-graſs	Peaſe	Wheat or Rye	Wheat

On the whole, though no invariable rules can perhaps be laid down for the cropping of land, as much muſt conſtantly depend on ſoil, ſituation, climate, and other leſs important circumſtances, the chief objects to be aimed at in this buſineſs would ſeem to be thoſe of well adapting the crops to the nature of the lands and kinds of huſbandry that are to be purſued, and that of alternating the green and root kinds with thoſe of corn, in ſuch a way as that the ſoil, while it remains the leaſt poſſible time in an unproductive ſtate, may be the leaſt robbed of its fertility. In this manner the culture of the field may approach that of the garden, and the deteriorating effects of ſucceſſive grain crops be guarded againſt, at the ſame time that more abundant ſupplies of both human and cattle food are produced.

From the whole of what has been advanced in reſpect to the nature of cropping lands, it muſt be ſufficiently obvious that the cuſtom of reſtricting tenants to particular modes or courſes of cropping their farms, is not only diſadvantageous in preventing the introduction of uſeful improvements, but in leſſening the quantity of produce that may be obtained, without injuring the ſoil in any improper degree. The only circumſtances that would ſeem neceſſary to be particularly attended to by land-owners, are thoſe of preventing the too frequent ſucceſſions of grain crops, eſpecially thoſe of the more deteriorating kinds, and which have a great tendency to render the land foul from being repeated at too ſhort intervals; while at the ſame time the manure that is raiſed from ſuch crops, as well as that formed from the conſumption of thoſe of the green kind, be carefully reſtored to the land. Where regulations of this nature are ſtrictly enforced, it appears almoſt impoſſible that land ſhould be much injured by any modes of cropping that may be adopted.

However deſirable it may be, it is unqueſtionably a matter of much difficulty to point out ſuch proportions of crops of different kinds as may be generally applicable to arable farms of different deſcriptions, as it is obvious that in every caſe a great deal muſt depend not only on ſoil, climate, and ſituation, in reſpect to markets, but on the kind of huſbandry that is practiſed, as well as various other circumſtances of a local nature. It would ſeem, however, that the leading principles in this buſineſs ſhould be, that the extent of land in the ſtate of natural and artificial graſs be fully adequate to the ſupport of ſuch a number of live ſtock of different kinds as may be ſufficient to ſupply ſuch a proportion of manure as is neceſſary for keeping the portion of ground under grain, root, green, or other crops, in the moſt perfect heart and order. Hence the ſpace of ground, to be conducted under grain, root, green, and other arable crops, muſt conſtantly be proportioned to the quantity of manure that can be raiſed by the keeping of different ſorts of domeſtic animals, while the number of the laſt muſt be regulated by the amount of the food that can be procured from the graſs and green cattle crops, which can be cultivated and preſerved for their uſe during the winter ſeaſon. Without conſiderable attention to theſe different circumſtances, it muſt be impoſſible, except near large towns, where manures can be obtained at a reaſonable rate, to cultivate land to the moſt advantage.

Where the convertible ſyſtem of huſbandry is practiſed, and the ground continued for only three years in tillage, and then laid down to graſs for one, two, or more years, according to the circumſtances of the caſe, the following may be a ſuitable and proportionate diſtribution of crops for a farm of about two hundred acres.

In ſtates of graſs - - - - - - -	110	acres.
Under fallow crops - - - - - - -	30	
In grain crops - - - - - - -	60	
	200	

The annual diſtribution of which may be in this way;

In the ſtate of old ſward - - - - - -	20	acres.
Under artificial graſſes, as clover, ſaintfoin, lucern, &c. -	10	
In the ſtate of irrigation or preſerved graſs - - -	5	
Under different fallow crops - - - - -	30	
Under wheat and barley, in ſucceſſion to the fallow crops	30	
Firſt year's crops of different graſſes - - - -	25	
Second ditto - - - - - - - -	25	
Third ditto - - - - - - - -	25	
In oat and other grain crops after breaking up the graſs	30	
	200	

It is not to be ſuppoſed that the above method can be exactly followed in every caſe; as circumſtances may ſometimes require a larger proportion of the land to be under grain, and at others under graſs or green cattle crops, according to the facility with which manure can be obtained, or as live-ſtock is more the object of the cultivator.

In the well-cultivated parts of Yorkſhire, the proportionate diſtribution of crops is thus ſtated *.

On a farm conſiſting of 150 acres, ſixty of which were a dry turnip ſoil, and the remainder a mixed clayey gravel on a wet bottom.

Annual diſtribution of Crops.

Wheat	30	acres.
Barley	20	
Oats	14	
Meadow-graſs	7	
Red clover	14	
Paſture	45	
Summer fallow and turnips	20	
	150	

On a red greet, and water ſhaken ſoil, incumbent on clay. Extent 200 ſtatute acres.

Annual diſtribution of Crops.

43 acres, wheat being 15 acres after fallow.
15 acres after clover lea.
13 acres after oats.
16 acres barley after fallow.
10 acres oats.
14 acres beans and peas.
70 acres paſture and meadow.
16 acres clover.
31 acres ſummer fallow.

200

* Corrected Agricultural Report of the Weſt-Riding of Yorkſhire, p. 90.

On a farm, extent 78 ſtatute acres, reſtricted to ploughing more than 40 acres, which is a dry gravelly ſoil.

Annual diſtribution of Crops.

18	acres wheat.
8	acres potatoes.
6	acres of oats.
8	acres of peas, cabbages, &c.
27	acres paſture graſs.
11	acres meadow loam.
78	

On a farm where the ſoil was lime-ſtone, clay, and moor. Extent 139 ſtatute acres.

Annual diſtribution of Crops.

Wheat - - - -	23 acres.
Barley - - - -	9
Oats - - - -	23
Beans - - - -	5
Meadow - - - -	12
Fallow - - - -	20
Paſture - - - -	47
	139

Grain Crops.—In the cultivation of moſt ſorts of corn crops, it is eſſentially neceſſary that the ſoil ſhould be reduced to a conſiderable degree of fineneſs, or what by writers on huſbandry is termed tilth, as where this is not the caſe they can neither be ſo well provided with nouriſhment nor be kept ſufficiently clean from weeds. There are alſo other reaſons that demand the ſuperficial parts of ſoils to be in a fine condition for the reception of grain crops, which are thoſe of the tender roots of the young plants being thus rendered more capable of eſtabliſhing themſelves perfectly in the mold, and of drawing from it a more regular ſupply of food from the more equal diffuſion of moiſture that muſt take place. Beſides, it is favourable in other ways; the ſeed is not only more perfectly but more equally covered, in conſequence of which the vegetation of the grain is more equal and expeditious*.

* Section on Fallowing of Land.

But, independent of the ſtate of the ſoil in regard to tilth, it ſhould be in a ſuitable ſituation in reſpect to dryneſs; as where the ſeed is put in where there is too great a degree of moiſture in the ſoil, it may ſuſtain injury by becoming rotten before the vegetative proceſs commences, as frequently happens to pea and other garden crops when put in during the winter months; and where the land is in too dry a ſtate at the period of ſowing the grain, injury may be ſuſtained by the want of that degree of moiſture which is neceſſary for perfect vegetation. Beſides, under this laſt circumſtance it may be more liable to be deſtroyed by worms, grubs, or other inſects. In theſe views the agricultor ſhould therefore be equally attentive to the preparation of the land, and the ſtate or condition in which it may be cropped with the greateſt chance of ſucceſs.

Wheat.—This is a ſort of crop which, from its being capable of ſuſtaining the ſeverity of winter in moſt caſes without much injury, muſt be conſidered of a hardy nature. Of this kind of grain there are two diſtinct ſpecies cultivated in this country; the ſmooth or polled wheat, and that which has a rough or bearded ear. The firſt ſort, of which there are many varieties, is by much the moſt cultivated, as it affords the fineſt kind of flour; but the latter, which is frequently termed *rivet* wheat, from its being capable of yielding a large produce on the more ſtiff and wet clayey ſort of ſoil, as well as from its being leſs liable to diſeaſe, and injury from wet when cut, is not unfrequently grown where ſuch ſorts of land prevail. The common wheat is moſt adapted to the dry and mellow kinds of ſoil, but may be cultivated on others where proper care is taken to keep the moiſture from ſtagnating too much on the land *.

* It is obſerved by Mr. Boys, an intelligent cultivator in the county of Kent, that the number of ſorts of this grain is annually increaſing, by importation from foreign countries. And that the *old* ſorts, are the *brown* and *yellow lammas*, the *white ſtraw*, *Fulham*, and the *white* or *egg-ſhell*. The *brown lammas* was the ſort chiefly cultivated in that county, till within theſe twenty or thirty years; but it has now given way to a variety of new kinds, as well as ſome of the other old ſorts. He found it from experiment the leaſt productive of the ſeveral kinds.

It is, he ſays, the *common brown-ſtrawed wheat*, that grows with a long jointed ear, the chaff of a dark brown colour, the ſtraw long and apt to fall, the hull or bran thin, the flour very white, and the corn mellow in grinding, for which reaſon it is eſteemed by the millers as the beſt of the old ſorts for their uſe. The *yellow lammas* reſembles the *brown* in every reſpect, except that the colour of the grain is of a yellow hue, and the chaff of a ſomewhat lighter colour.

The *white-ſtrawed wheat* takes its name, he obſerves, from the colour of its ear; and in other counties bears the appellation of the *Kentiſh white-ſtraw*. It ſends out a greater number of ſtems from the ſtool or plant than the other ſorts, and by that means is often a very thick crop on the land. The ſtraw is generally ſomewhat ſhorter than that of many other ſorts, and not quite ſo liable to fall in rainy ſeaſons.

It

The bearded or rivet kind is likewiſe ſaid, by ſome cultivators, to be the moſt ſuited to ſuch kinds of rich land as have been newly broken up, where there may be danger of the crop lodging from too great luxuriance, as it poſſeſſes the property of a greater firmneſs of ſtraw.

Among the numerous varieties of the ſmooth or polled kind of wheat, the white and the red are the moſt eſteemed in general; the former affording the whiteſt flour, while the latter has the greater produce.

There is likewiſe another ſort of this grain that may probably be cultivated to advantage in particular caſes, as where the turnip ſyſtem is much practiſed,

It is on theſe accounts much ſown in the eaſtern part of that county; but, from its dull colour, its having a thick bran, and often grinding very ſteely, is not much approved of by the millers.

The *Fulham*, it is alſo obſerved, produces a white ſtraw, which grows ſhort and coarſe: it is very productive, eſpecially on poor land; but the grain is very coarſe, and the bran thick: from which circumſtances it is the leaſt valuable to the millers of any of the above kinds.

The *white*, or *egg-ſhell wheat*, is known by its producing a white ſtraw, a ſmooth white chaff, and very white grain; the bran of which is ſomewhat thick, but the flour remarkably white. It works mellow in grinding, is very early ripe, and ſo free in the ear as to blow out in windy weather.

The *new* ſorts of wheat in that county are the *hoary white*, the *nonpareil*, the *pilbeam*, the *ſquare-ear*, and the *hoary brown*. The *hoary white*, by ſome called the *velvet-eared*, is by far the moſt valuable, becauſe it is very productive, and the beſt for the millers' uſe. The ſtraw is white and ſhort, the chaff covered with a thick fine down, ſomewhat of a browniſh hue; the grain remarkably ſmall, and of a dull white colour; the bran very thin, ſo that ſome grains are almoſt tranſparent when held up to the light. It grinds very mellow, and makes a beautiful fine white flour. From the quantity of down upon the chaff, and its ſmall ears binding up very cloſe in the ſheaf, in a rainy ſeaſon it is apt to vegetate very freely in the field; on which account it is not ſo proper to cultivate in a moiſt climate, and in ſmall incloſures that are not open to the winds and ſun.

The *nonpareil* is a ſort ſaid to be brought into this country from America; it has a bright ſtraw with a brown ear; and the grain is very white, large, and plump. It is very productive on all ſoils, thraſhes very free, and yields, in that operation, the greater part of its chaff; thereby producing a great quantity of horſe-meat. It grinds very mellow, and is well eſteemed by the millers.

The *pilbeam* is a brown wheat, growing very ſtiff, and is generally thick on the land. The grain is ſmall and plump, ſomewhat of a yellow brown. It is ſaid to be very productive on rich lands, and is a valuable kind to mix with others, but will not of itſelf make good bread, from its not working properly in the act of fermentation.

The *ſquare-eared wheat* is a very productive kind; but is apt to drop out in the field before it is ripe, and in gales of wind, from which it is not much cultivated.

The *hoary brown* is but lately introduced, and therefore little known.

There are two ſorts of *rivet wheat*, the *white* and *brown*; neither of which are much cultivated in Kent. They both ripen late in the ſeaſon, and are ſo coarſe and ſteely as to be unfit for making bread, unleſs mixed with a large proportion of a better ſort of flour. They, however, produce very abundant crops on ſtrong wet lands.

or other ſorts of green vegetables produced on an extenſive ſcale for the winter ſupport of animals, and where the ſituation is warm and early. This is the kind known to farmers by the name of *ſpring wheat*, from the circumſtance of its being put into the ground at that period. The culture of this ſort has, however, hitherto been introduced only in a partial manner.

This kind of grain is found from experience to ſucceed in general to moſt advantage on ſuch ſoils as are of the more deep, ſtrong, and fertile nature, but where the ſuperficial parts are not ſo ſtiff or adheſive as to be incapable of falling down or breaking into a fine ſtate. It may however be grown on the lighter deſcriptions of land, and in many inſtances afford good crops, though it has been well remarked by a practical writer, that, when introduced on ſuch ſoils as are very light, whether of the ſandy, gravelly, or chalky kind, a practice too common in moſt diſtricts where they prevail, great loſs muſt be ſuſtained in a national point of view from ſuch lands being more adapted to the production of other ſorts of crops *.

Wheat is the ſort of grain moſt generally ſown where the land has received the preparation of a complete ſummer fallowing; but it is probable that, except in particular kinds of land, as thoſe of the ſtiff clayey nature, and under particular circumſtances, as where they are moiſt, and have much tendency to the throwing up of weeds †, it may be grown to equal, if not more advantage, after many different kinds of green root and other crops. In this way it may be ſown after clover, tares, peas, beans, turnips, potatoes, and many ſimilar crops, according to the quality and ſtate of the land. In diſtricts where the flax and hemp culture is practiſed, it may likewiſe in ſome caſes be put in after ſuch crops.

But in whatever method, or after whatever kind of crop, this ſort of grain may be cultivated, the ſoil ſhould conſtantly undergo that degree of preparation that may be ſufficient, according to the particular circumſtances of the land, to bring it into a ſtate of conſiderable pulveriſation and mellowneſs, eſpecially in the more ſuperficial parts, as well as to prevent as much as poſſible the riſing of weeds; for, whoever has attended to the progreſs of this ſort of crop in ſuch lands as have been well broken down and reduced, and in ſuch as have been left in a lumpy crude ſtate at the time of ſowing, will have found the difference to be very conſiderable. When this kind of crop is taken after clover, the land ſeldom undergoes more than one ploughing, which is moſtly given immediately before

* Donaldſon's Modern Agriculture, p. 277.

† Section on Fallowing of Land.

the ſeed is ſown. But as the graſſy matter in many caſes, where this mode is adopted, is extremely apt to riſe and injure the crops in the more early ſtages of their growth, it may be better to follow the practice adopted in ſome diſtricts of uſing a ſkim-coultered plough *, as by this contrivance the remains of the clover weeds and graſſy material on the ſurface may be cut or ſkimmed off, and turned into the bottom of the furrow, where they are immediately covered with the looſe mold from below, to ſuch a depth that little or no inconvenience can be ſuſtained from them, while the land is thus rendered more clean and capable of being harrowed in a more perfect manner than where the common plough only is employed. Beſides, perhaps a better bed of mold is turned up in this way for the ſeed to vegetate in, provided the furrow is not made of too great a depth and breadth, and remain ſome time before it be ſown, which ſhould conſtantly be attended to by the agricultor in preparing this ſort of ground for wheat crops. But it is the cuſtom of ſome places † where the land is often continued for nearly two ſeaſons in the ſtate of clover, to break them up about the latter end of June, in the ſecond, giving them two and ſometimes three ploughings. Where the ſituation is favourable, and the weather turns out ſuitable for reducing the ſoil to a proper ſtate of tilth, this may be an advantageous practice, as by ſuch means great benefit may be obtained by cutting the graſs in the beginning of the ſeaſon in which it is to be ploughed up; but where circumſtances of ſo favourable a nature do not occur, ſuch a method of preparation muſt be leſs beneficial than that of giving only one ploughing.

It has been juſtly remarked, by an agricultor of conſiderable experience, that in caſes where the clover crops have been ſuch as to leave the land in a foul condition in reſpect to weeds, it would be highly improper to ſow them with this ſort of grain, as from its remaining for ſuch a great length of time upon the ground, they may be liable to have their ſeeds perfectly evolved and brought into the ſtate of vegetation. In ſuch caſes he ſuggeſts it as more advantageous to have recourſe to ſuch ſorts of crops as may require the frequent operation of hoeing during their growth ‡.

Wheat crops ſometimes ſucceed thoſe of the pea kind; but this is a practice that may probably be purſued with the moſt propriety and ſucceſs in thoſe diſtricts

* This purpoſe may be effected by any common plough, to the coulter of which an iron fin or plate is attached by means of a ſcrew or rivet, at the diſtance of about four inches from the point.

† This is the practice in the counties of Norfolk and Warwick, according to the author of Modern Agriculture.

‡ Middleton, in corrected Report of Middleſex.

that are from the nature of their ſituation ſufficiently early to admit of the land being fully cleaned and prepared by repeated ploughing and harrowing after ſuch crops have been removed, before the proper time of ſowing ſuch grain. But where they are ſo late as only to allow of the land being prepared by one ploughing before the period of ſowing, it is ſuppoſed by ſome to be an extremely hazardous practice to attempt the culture of wheat after ſuch crops, as, unleſs the ground be in a high ſtate of tilth, there is little chance of a good crop being produced *.

It is the regular practice of ſome counties to cultivate beans and wheat alternately on the ſame land for ſome time. This is the caſe on the ſtronger kinds of ſoil in the county of Kent, on which it is found to anſwer in a very beneficial manner. And where wheat is only occaſionally ſown after ſuch crops, as is the caſe in many diſtricts, it is alſo frequently found an uſeful practice; but in all ſuch caſes the beans ſhould be cultivated in drills at from twenty to thirty inches diſtance, in order that they may admit of being hand and horſe hoed in the moſt perfect manner. If this method has been followed, and the buſineſs of hoeing during the growth of the crops effectually performed, the land may be ſufficiently prepared for the ſucceeding wheat crops by once ploughing, as the ſoil, from being thus kept clean, and in high tilth, can ſcarcely fail of affording a good produce.

In the more early diſtricts, and where the lands are preſerved in good order by judicious modes of cropping, wheat may alſo be grown after beans, whether cultivated in the drill or broadcaſt ſyſtem, with ſucceſs, as there may be ſufficient time to give the neceſſary preparation before the period of ſowing, which cannot be the caſe, as has been ſeen, where they are late, and there is only time for once ploughing †.

In other places it is however found advantageous when this ſort of crop is to be grown after either peas, beans, or tares, to plough the land in as light or ſhallow a manner as poſſible, and then harrow and rake out the roots and weeds, ſo as that they may be conſumed on the ground in heaps; the field being after this formed into proper ridges for the reception of the ſeed by ploughing again a few inches deeper than at the firſt. And in ſome caſes it is even harrowed after the ſecond ploughing, and ploughed a third time ‡.

Wheat is occaſionally cultivated after turnip crops; and which may in many caſes be practiſed to advantage on the heavier turnip ſoils, eſpecially where they

* Modern Agriculture, vol. II. p. 273.

† Donaldſon's Modern Agriculture, vol. II.

‡ Middleton's Report of the Agriculture of Middleſex, p. 166.

have been kept clean from weeds by repeated hoeing, and conſumed upon the land at ſuch early periods as to admit of the ground being prepared by once ploughing in a light manner. The late crops on the lighter ſorts of land may be more properly managed by ſowing them with ſpring wheat, or leaving them for barley, for either of which they may be prepared by two or three ſhallow ploughings. Spring wheat in this mode of preparation has, in ſome caſes, been found to approach that of the autumnal ſowing.

Where the turnip crops are late, and cannot be conſumed in ſufficient time for the land to be prepared ſo as that the ſeed may be put in before December, it is probably the moſt ſafe method to let it remain to be ſown in the ſpring, as by ſuch means there will be an opportunity of getting the ground into a proper ſtate of preparation for the reception of the ſeed, which could not otherwiſe be the caſe. And under ſuch circumſtances it is undoubtedly the moſt advantageous plan to employ that ſort of wheat which is uſually known by the name of *ſpring wheat*, as from its early nature it is more adapted to be ſown at ſuch a ſeaſon.

Where this ſort of crop is intended to be cultivated after potatoes, which, as they have a great tendency to lighten the ſoil in a very great degree, as well as to exhauſt it, ſhould never be the caſe on the lighter ſorts of land in backward ſituations, or under any circumſtances where a ſufficient proportion of manure has not been applied for the potatoe crops, one light ploughing immediately before the ſeed is put in may be in moſt caſes an adequate preparation, as where proper attention has been beſtowed in the culture of ſuch crops, the ſoil is generally left in a ſufficiently fine condition.

It has, indeed, been obſerved by an intelligent cultivator, that the cauſe of wheat not ſucceeding well after potatoe crops in many inſtances is, that, beſides the land being rendered too light and porous by the growth and cultivation that are requiſite for them, the wheat is more expoſed to the injurious attacks of the grub, earth-worm, and other inſects; and in ſome expoſed ſituations, from the ſeed-time being too long protracted, the practice becomes obviouſly improper *.

In ſituations where flax and hemp are grown, this kind of grain may frequently be cultivated to advantage after them; in which circumſtances, as weeds are apt to riſe, it is always proper that the land ſhould be ploughed over two or three times, in order that a fine ſtate of tilth may be produced. The cuſtom of giving but one earth after ſuch ſorts of crops can ſeldom or ever inſure an abundant produce.

Experience has ſhewn, in the moſt clear and ſatisfactory manner, that this ſort

* Middleton, in Report of Middleſex.

of crop ſhould never, where it can be avoided, be grown after other kinds of grain crops, as rye, barley, or oats; and that the manure ſhould not be applied for it, but for ſuch crops as may precede it *. Where the contrary practice is adopted, the crop is not only liable to be injured by the rampant growth of weeds, but from its being more apt to be diſeaſed.

Whatever the nature of the ground may be, or the kinds of crops that precede this ſort of grain, it would ſeem that the preparation ſhould always be ſuch as has a tendency to reduce the ſoil to a pretty high degree of pulveriſation, as under ſuch circumſtances the vegetation of the crop is not only more perfect and uniform, but from the evenneſs of the ſurface, and compact ſtate in which it is left, is more fit for affording ſupport and protection to the roots of the plants, by allowing them to ſpread and extend themſelves with greater readineſs in the fine mold thus provided, as well as by its falling down more cloſely about them. It has, notwithſtanding, been maintained by ſome agricultors, probably without ſufficiently attending to the ſubject, that a rough or cloddy ſtate of the ſurface is the moſt proper condition for the reception of this ſort of crop, as the young plants are thereby better guarded againſt the effects of the ſevere cold that frequently occurs in the winter ſeaſon. It is probable, however, that cold is ſeldom hurtful in any great degree to this ſort of grain, except where combined with too much moiſture, or where ſudden froſts and thaws have the effect of rendering the ſuperficial parts of the ſoil ſo light and open as to be incapable of affording a proper ſupport for the roots of the young plants.

Time of ſowing.—The exact periods at which this ſort of grain may be put into the ground with the greateſt chance of ſucceſs, under different circumſtances of ſoil and climate, have not yet, ſo far as we know, been fully aſcertained by experiment. In addition to the obſervations that have been already made in ſpeaking of ſowing in general, it may, however, be uſeful to remark, that the earlier the ſeed of the autumnal ſowings can be put into the ſoil, the greater chance the young plants will have of being well eſtabliſhed in the ground before the froſts take place, which we have juſt ſeen to be a circumſtance on which the welfare of the crop in a great meaſure depends. Beſides, the ſtate of the land, and that of the ſeaſon, is much more favourable for the proceſs of vegetation when the crop is put in at an early period, than when it is delayed to a late one; the ſtate of the weather in the latter caſe often admitting of only a very languid and imperfect growth until the ſpring, by which the crop muſt be ex-

* Middleton's Report of the Agriculture of Middleſex.

poſed to much danger from various cauſes. Indeed experience has abundantly ſhewn that late ſown wheats ſeldom ſucceed ſo well, or afford ſuch plentiful crops, as thoſe that are put in early. But when ſown too early, there may notwithſtanding be danger of the crop running too much to ſtraw, and conſequently of the grain proving light in the ear. From the beginning of September to the middle, or even the end, of October, may probably be conſidered as the moſt favourable period for this buſineſs. This is, indeed, confirmed by the eſtabliſhed practice of the moſt correct farmers in almoſt every diſtrict of the kingdom, where this ſort of grain is grown *. If ſown earlier, eſpecially on the heavy kinds of ſoil, the land is for the moſt part in too hard and lumpy a ſtate to allow of the ſeed being properly covered by the harrow; and in the lighter ones in too dry a condition for the grain to vegetate in a proper manner; and, when delayed later, the ground, in one caſe, is apt to become too wet and cloſe by the falling of the autumnal rains, and in the other too looſe and porous from the action of the froſts on it. It is remarked by the writer juſt mentioned, that more than four-fifths of the whole of this ſort of grain is ſown between the middle of the firſt and the end of the laſt of the above months.

There are, however, circumſtances that may render the times of ſowing different from the above; as where the ſoils are of the rich, fertile, loamy, chalky, or gravelly kinds, it may be better to defer it in many inſtances to a conſiderably later period, as when ſuch warm ſorts of land are cropped too early, they are apt, it is ſaid, to puſh the plants forward in ſuch a rapid manner, that they become weak and ſpindling in the early ſpring months; and at the ſame time the crops are more liable to be infeſted with weeds, on account of the ſeaſon being then more favourable to their growth †.

The practice of putting in crops of this ſort ſo late as the latter end of November and beginning of December frequently depends on the crops that precede them not being capable, from the lateneſs of the ſituation, or other cauſes, of being taken off ſo early as that the land may be made ready for the wheat crop in the proper time. This is often the caſe after peas, beans, tares, turnips, and other ſimilar crops. In theſe caſes, on the lighter ſorts of ſoils, and where drill culture is employed, it may often be a more adviſable practice to ſow in the ſpring, as by ſuch a delay the ground may be brought into a more perfect ſtate of preparation than could be the caſe in ſowing it ſo late in the winter. When this method is adopted, that ſort which is known by the name of *ſpring*

* Modern Agriculture, vol. II. p. 275.

† Banniſter's Synopſis of Huſbandry.

wheat may be the moſt proper, though it is evinced, by the ſucceſs of experiments in ſowing at this ſeaſon, that any of the white thin-ſkinned ſorts of wheat may be employed, not only with ſafety, but with the proſpect of affording a good produce *.

Seed.—The quantity of ſeed that is to be made uſe of in different caſes we have already ſeen to depend upon and be regulated by a variety of different circumſtances, but in general from two to three buſhels, according to the ſtate of the ſoil, the nature of the climate, and the period in which it is put into the ground, may be eſteemed the moſt ſuitable proportion for ſoils of a medium degree of fertility, under the broadcaſt method of huſbandry; but where the drill ſyſtem of culture is practiſed, a conſiderably leſs proportion may be ſufficient for the purpoſe, as has been explained in a more full manner in ſpeaking of the nature of ſowing, or putting different ſorts of grain crops into the earth.

On the rich ſoils of Glouceſterſhire, the quantity generally ſown has been ſtated to be about ſeven pecks; while in many other diſtricts, as Yorkſhire, it is from eight to twelve †. Where the lands are in a ſuitable ſtate of tillage for receiving crops of this grain, ten pecks have been adviſed by a practical writer as the medium proportion ‡. Larger quantities are likewiſe frequently ſown in the northern parts of the kingdom ‖; but it is obvious, that, where ſuch large proportions of ſeed are made uſe of, the plants muſt be liable to be drawn up too much, and the crops in conſequence to become weak and imperfectly fed, as well as ſmaller in the ſize of the ears. There may alſo be diſadvantages from making uſe of too ſmall proportions of ſeed, from the ground not being properly covered with plants: but where care is taken in the after-culture of the crops, leſs danger is probably to be apprehended from this than the other extreme, as a great number of plants will be ſupplied by the tillering or ſhooting out of new ſtems from the joints about the ſurface, in conſequence of the mold being laid up againſt them. On this account the drill method of culture may be the moſt proper when this ſort of grain is raiſed upon light ſoils that are in a ſtate of ſufficient cleanneſs, as well as from its affording a more looſe and penetrable earth for the coronal roots to ſtrike and be formed in. The broadcaſt method is, however, that which is the moſt commonly employed, eſpecially on the heavy kinds of land, whether of the clayey or loamy deſcriptions, the ſeed being caſt over the ſur-

* Exter, in Bath Papers, vol. IX.

† Marſhall's Rural Economy.

‡ Donaldſon's Modern Agriculture, vol. II.

‖ Corrected Reports of Mid Lothian and Perthſhire.

face of the ground ſoon after the laſt earth or ploughing has been given by the hand, and immediately harrowed in by the lighter kinds of harrows. There is, however, another practice that prevails in ſome diſtricts, which is that of ſowing the ſeed in a partial manner, one portion being turned in by the ſecond or third ploughing, and the other afterwards harrowed in. This method would ſeem to be attended with an additional expence, without any adequate advantage being derived from it; and if great care be not taken to turn the ſeed in with a very ebb or light furrow, eſpecially in wet ſeaſons, and where the land is of a heavy and retentive quality, inconvenience may be ſuſtained by much of the grain being deſtroyed before the proceſs of germination is effected. Beſides, there muſt be great inequality in the growth of the crop, a circumſtance which we have ſeen to be injurious to the welfare of the wheat. After the ſeed has been put in, the land ſhould conſtantly be laid as dry as poſſible, by the conſtructing of proper drains and water-furrows.

After-culture.—The manner in which the crop has been put into the ground, the ſtate of the land, and the preparation on which it was ſown, may produce ſome differences in the culture that is neceſſary while it is growing. In every caſe it muſt, however, be kept perfectly clean and free from weeds, either by means of the horſe or hand-hoe, as they not only injure the crop in its growth, but leſſen the value of the ſample at the market. But the ſtirring of the mold on the ſurface among the plants may frequently be uſeful in other intentions beſides that of preventing the growth of ſeed weeds; for, as in the heavy kinds of ſoil, that are moſt adapted to this grain, the more ſuperficial parts are liable to become ſo hard and baked as not to be eaſily penetrated by the new-formed or coronal roots of the plants in the early ſpring months, eſpecially when they are very dry and have been preceded by much wet, the looſening of the earth, by any means whatever, muſt be of conſiderable utility. This effect is generally ſhewn to have taken place by the appearance and progreſs of the crop, which becomes of an unhealthy yellow colour, and advances but little in its growth. In ſuch caſes it has been ſuggeſted that harrowing once, or oftener, in a place, may be of much ſervice in the early ſpring months *. Where the crops are thin and of feeble growth, this operation may produce beneficial effects, by affording a ſort of earthing-up to the weak plants, and thereby promote a more vigorous growth, at the ſame time that a number of new ſhoots are ſent off from the joints thus covered, and the crop, in conſequence, rendered more full and abundant; and

* Middleton's Report of Middleſex.

where the grain is too thick upon the ground, it may alſo be uſeful by drawing out and deſtroying many of the plants. It has likewiſe been ſuſpected by an acute writer, that many of the root fibres, by being torn in the operation, may prevent the over luxuriance of the ſtem and leaves, and by that means promote the more early fructification of the plants *.

Rolling the land, either without having recourſe to the harrow or after it has been employed, eſpecially where the ſurface is cloddy, and the operation is performed when the ground poſſeſſes a medium degree of moiſture, may be of utility in the ſame way, as well as by forcing the roots of the wheat into the earth, and by that means cauſing new ſtems to riſe †. On all the light thin ſoils, when this ſort of grain is cultivated upon them, much benefit may alſo be produced by the uſe of the roller, by the roots of the plants being thereby prevented from being ſo eaſily looſened and thrown out of the ground. And the ſame practice is recommended as generally uſeful where clover or graſs ſeeds are ſown with wheat crops, as a means of rendering vegetation more ſecure ‡.

The former operation may likewiſe be practiſed with advantage, in the way of preventing the deſtructive ravages of the worm ‖.

In caſes where the land is not in a ſufficient ſtate of fertility or preparation to bring the crops to perfection, it may be neceſſary to make uſe of top dreſſings. Subſtances of both the ſolid and fluid kinds have been made uſe of for this purpoſe; the firſt conſiſt chiefly of the dung of different ſorts of birds after being brought into a powdery ſtate, bone-duſt, ſoot, peat, aſhes, and various ſaline matters. The latter are principally the drainings of dung-hills and other ſimilar liquid materials. The former ſhould be thinly ſown over the crops, with as much evenneſs as poſſible, as early in the ſpring as horſes can be admitted upon the land without injury; and if it can be done when the weather is inclined to be moiſt, it is the better. A roller may then be paſſed over the crop with advantage. Where the latter ſubſtances are made uſe of, care ſhould always be taken that the plants be not injured by having too large a quantity of ſuch fluids applied to them.

The practice of tranſplanting wheat may be had recourſe to in particular caſes, probably with beneficial conſequences, as where there are ſome parts of ſuch crops too thickly ſet upon the ground, while others are too thin, irregular, or patchy; as by thinning and ſetting out the plants of ſuch over-abundant parts among thoſe that are deficient, much ſervice may be done to each of them. The

* Darwin's Phytologia, p. 292.
† Ibid, p. 293.
‡ Corrected Report of Middleſex.
‖ Synopſis of Huſbandry, p. 63.

firſt will be rendered more capable of admitting the operation of the hoe, and thereby of ſupplying more abundant nouriſhment for the luxuriant vegetation of the plants; and the latter be ſupplied with the proper number of plants, which could not be accompliſhed in any other way. It has been ſuggeſted, that, when cultivated in the garden, one acre would be capable of affording ſets for an hundred, when planted after being properly divided, at the diſtance of nine inches from each other; and as the buſineſs of tranſplanting is to be performed in the ſpring, it is ſuppoſed that crops of this grain may be raiſed in this manner on lands that poſſeſs a greater degree of moiſture than is ſuited to the healthy growth of wheat in general. Beſides, clean crops may be produced in this way with much greater certainty, as where the ground is ploughed over juſt before the plants are ſet out, the grain may riſe much quicker from the plants than the weeds from their ſeeds, and the crop, in this way, overpower ſuch noxious plants *. Many advantages of other kinds have been ſtated by other writers as the reſult of this practice †.

The feeding of wheat crops, where too forward or luxuriant in the early ſpring months, by means of ſheep, is a practice that has been found of much benefit in many caſes. The good effects in ſuch inſtances are ſuppoſed to ariſe from the removal of the upright central ſtems, by which means different new lateral ſtems or root-ſcions are ſent off or brought forward with more vigour, by the acquiſition of a larger proportion of nutritious matter from the joints in conſequence, that muſt otherwiſe have been exhauſted in ſupporting the central ſtems ‡.

This practice has been found by experience to be the moſt uſeful on ſuch ſtrong and fertile lands as are apt to produce a larger proportion of ſtraw than can be properly ſupported. In theſe caſes advantage has frequently been derived by feeding off the blade at two or more ſucceſſive times; but in managing the buſineſs, great care is neceſſary to ſee that the whole is completed before the crop begins to ſpindle, otherwiſe more injury than good may be produced. But, on the lighter and more poor deſcriptions of ſoil, the practice muſt be employed with great caution, as on ſuch lands the growth of the crop may be ſo retarded as to become weak and ſpindly. Beſides, on thoſe lands where they are very light, and the crops thin, injury may frequently be done, by many of the plants being pulled up on account of the cloſeneſs of the bite of the ſheep. They ſhould therefore never be ſuffered to remain upon the crops when the weather is wet and the ſurface of the ground much looſened, or after ſudden froſts and thaws; as in

* Darwin's Phytologia, p. 291.
† Bogle, in Bath Papers, vol. III.
‡ Ibid.

ſuch caſes much harm may be done by the plants' being pulled up and deſtroyed. The treading of the animals may, however, be of great ſervice in all the light ſorts of land, and where the crops are thin, as by that means the earth will not only be preſſed more cloſely about the roots of the plants, but the ſtems in many inſtances ſo forced into the ground and covered up, that new ſhoots will be ſent off laterally, and the crops be thus rendered more full on the land. But where the ſoils are very ſtiff and adheſive, the growth of the crops may be checked and retarded by the practice, and of courſe the ſhoots thus cauſed become weak, affording only ſmall ears and light grain *. The obſervation and experiments of the ſame writer have indeed fully convinced him that wheat ought not to be fed down with ſheep, unleſs it be very rank in January, and that ſuch crops ſhould only be fed as were ſown early.

But though this practice has much relation to that employed in gardening, of ſtopping the growth of the main ſtems of ſome ſorts of plants, as thoſe of the cucumber and melon kinds, by rubbing off or cutting away the central buds, in order to expedite their fruiting; yet, in wheat crops, where the principal ſtems are eaten down, except when they are early and of very luxuriant growth, the ears of the new ſhoots may not have time to perfect their ſeed, and of courſe become light and ſhrivelled in the grain; and the new ſtems, from their weakneſs, be more apt to fall down and be lodged. Theſe are circumſtances that have been frequently obſerved to occur in the feeding down of wheat crops by means of ſheep †. The ſame philoſophical writer alſo ſuggeſts that, in reſpect to the culture of wheat crops, the moſt beneficial method is that of promoting as much as poſſible the time of bloſſoming, while that of ripening is protracted ‡, as it is for the farinaceous reſervoir of nutriment depoſited in the cotyledon of the new ſeed, in order to ſupport the growth of the *corculum* or freſh embryon, that the plant is cultivated; which farinaceous depoſition is effected in the interval between the bloſſoming and ripening of the corn, either before the impregnation of the pericarp or ſeed-veſſels, or afterwards; and the weight and plumpneſs of the grain is thus augmented.

The eating down of crops by ſheep may therefore often be hurtful, by retarding the period of bloſſoming, as well as by reſtricting the growth of the ſtems ‖.

But beſides the advantage derived from the feeding down of wheat crops with ſheep, they may ſometimes be employed with benefit in other views; for

* Bath Papers, vol. I. p. 66. † Tull's Horſe-hoeing Huſbandry, 4to. edit.

‡ Tull's Horſe-hoeing Huſbandry, 4to. edit. p. 147. ‖ Darwin's Phytologia, p. 144.

as the coronal parts of the roots of ſuch crops are liable to be laid bare and expoſed for ſome inches in length, about the ſurface of the earth, during ſevere froſty winters, the turning in of ſheep upon them in ſuch circumſtances, when the ground is moiſt, and keeping them in motion, may tend to preſs them into the looſe ſoil, and in that way produce new roots, as well as afford covering and protection to ſuch as have been denudated.

It is likewiſe a practice with ſome farmers, who contend that much advantage is derived from it, to turn ſheep upon the crops where danger is apprehended from worms, ſlugs, or other inſects; in order that, by keeping them conſtantly in motion, ſuch animals may either be wholly deſtroyed, or ſo fixed in the ſurface mold as to cauſe their more gradual death *.

There are many inſects that are highly injurious to wheat crops in mild and open winters, as well as during the ſpring, and ſometimes in the early ſummer months, by eating off and deſtroying the ſtems at the joints about the ſurface of the earth, which are in ſuch parts ſweet and tender, from their containing a portion of ſaccharine matter, and being of young growth. In theſe caſes the blades of the wheat plants drop down and become withered, by which the crops are frequently in a great meaſure deſtroyed.

The principal of theſe deſtructive animals does not yet ſeem to have been deſcribed with ſufficient correctneſs by writers on agriculture †; it is, however, probable that there may be different varieties of the ſame grub, that may be hurtful to grain crops. One kind of grub is aſſerted to be annually found in wet ſituations in larger or ſmaller quantities, according as the preceding ſeaſon has been hot or cold: and that while it continues in the ſtate of egg it cannot be injured by any ſeverity of weather that may occur. Even in the grub ſtate it is not capable of being much injured; and when in that of the fly it is equally hardy. The only period in which it appears to be ſuſceptible of injury, is that of its tranſmutation from the grub to the *aurelia* ſtate, in which ſtage it is capable of being deſtroyed by cold and wetneſs; and as this change moſtly takes place ſome time about the end of May, or in the early part of June, at which times rain generally falls in abundance, the whole, except ſuch as have ſecured themſelves in dry hills of mold, in meadows, or the borders of ditches, are annually killed. On arable lands few or none are believed to eſcape to effect the

* Corrected Report of Middleſex.

† It has been ſuggeſted by the author of a paper in the twenty-fifth volume of the Annals of Agriculture as belonging to the genus *tipula*.

purpoſe of propagating their kind, unleſs in ſuch ſeaſons as are unuſually droughty during the time of their change into the aurelia ſtate *. Hence the rains that fall at ſuch periods are not only beneficial in promoting the crop but in deſtroying this ſort of inſect.

Beſides this, it is obſerved in the ſame work that there are ſeveral other grubs brought forth at all ſeaſons in dry lands, which are not leſs injurious to corn crops than that juſt deſcribed. They equally poſſeſs the power of reſiſting the hurtful effects of the weather in every ſtage but that in which they are changed into the aurelia ſtate, when moiſture and cold has the power of readily deſtroying them. The whole of the grubs that are produced on ſoils of the more dry kind are ſaid to be of the moth tribe.

It is added, that the grub, when the autumn has been mild and warm, is brought into exiſtence about the latter end of October, and proceeds in its growth as long as vegetation continues in any degree; after which, probably from the want of food, it ſeems to remain at a ſtand till the ſpring ſeaſon, when its ravages ſoon become evident. It begins to increaſe in ſize towards the end of February, and continues to grow till the early part of May, when it is often more than an inch in length, and one third of an inch or more in circumference. It is ſaid to be then extremely deſtructive, eating through the roots of the ſtrongeſt ſtems of corn plants in a very quick manner. And it is ſtated, that on taking one of them, and putting it into earth, conſiſting of a ſoft black loam, about mid-day, covering it well, at the root of a plant of oats that had ſent out thirty-ſeven off-ſets, and which had been well earthed up, the plant, on being examined about the ſame time the ſucceeding day, was found to have its leaves hanging down in a declining ſtate, and the root, with the whole of the off-ſets, ſo injured as to be utterly incapable of recovery.

In mild ſeaſons, that are favourable for the propagation of grubs, they become numerous and highly detrimental; but, as has been juſt obſerved, they moſtly periſh annually, the race being preſerved only by the depoſition of ova in the borders of ditches, plantations, and coarſe fogged herbage, in which the *aurelia* is protected from injury by moiſture.

It has been found that the grub commits its principal injury on corn crops juſt after the germination or ſprouting of the grain, by devouring or eating away the young ſhoot before it ſhews itſelf above the ground. When the plants are up above the ſurface, and have acquired conſiderable ſubſtance, there is much leſs danger from the ravages of theſe animals, except where they are very nu-

* Farmer's Magazine, vol. II. p. 365.

merous. During the day they are ſaid to be moſtly found from half an inch to an inch and a half below the ſurface; and they are not ſuppoſed to come much above the ground during the night *.

Various means have been ſuggeſted for the purpoſe of deſtroying theſe animals, and preventing their ravages on grain crops; but hitherto probably without much ſucceſs. The ſubſtances that have been chiefly employed in this intention are lime and ſaline matters †; but it is probable that neither of them are fully effectual in preventing the deſtructive ravages that are often experienced from ſuch animals, as it has been found by experiment that the mixing of ſuch materials, eſpecially the lime with earth, by which it is ſoon ſaturated, does not prevent them from propagating and continuing in the mold ‡, and conſequently has but little effect in preſerving crops from their attacks. But though lime, when combined with the mold of ſoils, ſo as to become perfectly effete by the abſorption of carbonic acid both from it and the atmoſphere, may not have much power in deſtroying the grub; there can be little doubt, that when applied in its cauſtic or moſt active ſtate, it will prove deſtructive to it, as well as moſt other animals of the inſect kind. It has indeed been remarked, that both hot lime and alkaline ſalts are capable of deſtroying ſuch noxious inſects as feed upon the roots, ſtems, and leaves of field plants, by the property they poſſeſs of combining with and reducing the organiſation of their bodies ‖. This effect would not however ſeem to be produced on living animals, except where ſuch ſubſtances are laid on in very large proportions, by which the crops would be in danger of being deſtroyed. It is added by the ſame author, that neutral ſalts may often be made uſe of with ſucceſs in the ſame intention.

Theſe are ſuppoſed to produce their deſtructive effects on ſnails, ſlugs, grubs, and other ſimilar animals, by cauſing ſuch exceſſive evacuations, by their powerful action, that they are incapable of withſtanding them. In this view it is probable that, in the neighbourhood of the ſea, ſuch ſand as has been conſtantly for a long time covered by the tides might be employed with advantage in the way of a top-dreſſing where wheat or other crops are injured by ſuch animals. But when either cauſtic lime or ſea ſalt is laid on in the way of top-dreſſing for grain crops, in order to deſtroy the grub, when exiſting at their roots, immediately below the ſurface of the ground, great care ſhould be taken that they be not

* Annals of Agriculture, vol. XXV, p. 407.

† Of the latter kind are *ſoapers' aſhes, bleachers' aſhes, refuſe pot-aſh*, &c.

‡ Annals of Agriculture, vol. XXV. p. 406.; Darwin's Phytologia, p. 362.; and Farmer's Magazine, vol. II. p. 365.

‖ Dundonald's Connection of Agriculture with Chemiſtry, p. 136.

poſſeſſed of ſuch cauſticity, or applied in ſuch quantities, or ſo unevenly, as to hurt the young plants by their too powerful operation on them.

Soot is likewiſe a ſaline ſubſtance that has been much made uſe of in different diſtricts for ſowing over young wheat and other grain crops when injured by worms, grubs, or other inſects that feed upon and deſtroy the tender ſtems, leaves, and roots of ſuch plants. It is a material which, in addition to carbonaceous and earthy matters, conſiſts of mineral or reſinous oil, made capable of ſolution in water by the large proportion of ſaline ſubſtance which it contains. The ſolution thus formed, it is aſſerted, "is an extremely bitter, high coloured, oily liquor, which not only poiſons the inſect on which it may fall, but alſo communicates a bitter taſte to the ſurface of the roots and leaves of plants, thus rendering them unfit for the food of ſuch inſects *." But the effects of this ſubſtance may be uſeful in other ways beſides that of deſtroying inſects; the growth of the plants may be ſo quickly promoted by the bituminous oily ſolution formed by the ſaline principle of the ſoot, as to allow no time for the ravages of the inſects on them †.

It has alſo been ſuggeſted, that where the grub is prevalent, rolling the land in the early ſpring months, ſoon in the morning, may have a tendency to cruſh and deſtroy them: and that where the fly is found to abound, and come out in the ſummer evenings on the graſs lands or fallows, it is probable that, by rolling at that time, the return of it into the earth, as well as the depoſit of the ova, may be prevented, and the future propagation of the inſect be guarded againſt ‡.

As the ova of this deſtructive animal is found to be chiefly depoſited in the long graſs on the ſides of hedges and ditches, it has been propoſed, as a ſure mode of preventing the propagation of the grub, to keep the tops of ditches and hedge-ſides perfectly clean, and free from the coarſe long herbage with which they are uſually covered ‖. And, on the ſame principle, the keeping of clover ſtubbles cloſely eaten down by ſheep or other animals, after the hay has been taken, till the wheat crop is nearly ready to be put in, has been found in ſome meaſure an effectual remedy againſt the deſtructive attacks of this inſect §.

Beſides grubs, there are other inſects which ſometimes commit depredations on grain crops. One of theſe, which is believed to be the *thrips Phyſapus* of Linnæus ¶, is found to attack the late bloſſoming ſtems on their coming into flower, on which account early ſowing may be the moſt effectual remedy.

* Dundonald, on the Connection of Agriculture with Chemiſtry. † Ibid. p. 138.

‡ Darwin's Phytologia, p. 369. ‖ Farmer's Magazine, vol. II. p. 365.

§ Annals of Agriculture, vol. XXV. ¶ Tranſactions of Linnæan Society, vol. III.

But, in addition to the attacks of theſe animals, wheat crops are often expoſed to injuries of other kinds, ſuch as the mildew, blight, blaſt, and ſmut.

The firſt of theſe vegetable diſeaſes is frequently found to affect wheat and other crops, in their more advanced ſtages of growth, in ſuch ſeaſons as are wet and gloomy, for ſome length of time together, without much ſun. The nature of this *mucor mould*, or *mildew*, ſeems not yet to have been fully inveſtigated by writers on huſbandry; but, from the obſervations contained in an ingenious paper in the ſeventeenth volume of the Annals of Agriculture, there appear to be two varieties of it, the *black* and the *red*. Various conjectures have been entertained by writers concerning the cauſe of the diſeaſe; the moſt probable of which ſeems to be, that it is a plant of the *fungus* kind, which, like others of the ſame ſort, is capable of proceeding in its growth in cloſe ſhaded ſituations without much change of air, and which by its roots penetrates the veſſels of the plants to which it attaches itſelf, but which were probably, however, previouſly in a morbid condition.

As moiſture, and a confined ſtate of air from ſhade or other ſimilar cauſes, have obviouſly much effect in producing the mildew in wheat and other grain crops, it ſeems not improbable that the beſt method of preventing or removing it would be that of not having the plants too much crowded together, but thin and open, ſo that light may be fully admitted, and a free circulation of air take place among the plants. This may be the moſt perfectly accompliſhed by the corn being ſown in rows, with ſufficient diſtances between them. Therefore, on lands that are ſubject tomil dew, the moſt advantageous method may be that of ſowing the grain by means of the drill, and not too thickly in the rows. Where the diſeaſe is preſent, the moſt adviſable method, in order to its removal, may be that of thinning out the weakeſt plants as much as poſſible, that more air and light may be let in, and by that means the ſtrength and vigour of the crop be increaſed, and the diſeaſe eradicated.

It has, indeed, been lately ſuggeſted, that, "as the greater dampneſs of ſome land ſupplies one permanent cauſe of mildew, as well as its being too much overſhadowed by thick foliage, the methods of prevention muſt conſiſt in properly draining the land, and uſing drier kinds of manure, as coal aſhes and bone aſhes *, as well as by thinning the crops." And it may be adviſable, in the ſame view, "to ſow early in the ſeaſon, for the purpoſe of procuring forward crops, as this diſeaſe is ſaid more to injure late crops, owing to the greater dampneſs of the ground in autumn †."

* It would probably be better, and certainly more economical, to make uſe of bones in the ſtate of a coarſe powder.

† Darwin's Phytologia, p. 121.

The *blight* * is an affection of the vegetable kind that not unfrequently attacks wheat crops in ſeaſons that are more than ordinarily moiſt. It has been found, that, in this diſeaſe, the green blades and ſtalks are beſet with ſmall ſpots of a black or ruſty colour, before the ear becomes affected; and that after the grain has begun to ſhoot, and is fairly come into ear, many of the heads are often completely empty; but, in ſome caſes, only empty in the upper half, the under remaining perfectly full. In others again, the ears are found to have alternately a plump well-filled *pickle* and an empty huſk; and that in ſome, though not quite empty, they include only ſhrivelled imperfect grains, or what are termed *hungry pickles* by dealers. In different inſtances ears are obſerved, that are partly hungry and partly filled in a proper manner; and that in as large proportion, there is an hungry and well-filled grain alternately: in ſhort, that various ears, that appear well filled, on opening the huſks are diſcovered to be covered with ſpots of a black and ruſty caſt. A number of the ſtems are in ſome inſtances met with that are perfectly withered their whole length. When ripened, the crop, in particular caſes, is obſerved to have a dirty ſpotted appearance, as if ſprinkled with ſoot, rather than the uſual clean healthy yellow aſpect; and the parts of the ſtraw, or ears, that are not thus ſpotted, are neither white nor yellow, as is uſual, but of a colour of the duſky or aſh kind †.

Theſe appearances, which ſhew themſelves in the different ſtages of the blight, are ſuppoſed, by the ſame author, to prove the exiſtence of an inſect as the cauſe of this vegetable diſeaſe ‡; and that as the greateſt injury is almoſt in

* The *uredo frumenti* of ſome writers.

† Somerville in Communications to the Board of Agriculture, vol. II. p. 207.

‡ In the paper juſt mentioned, which contains much valuable obſervation reſpecting the nature of the blight, an inſect that produced much injury to the ears of the grain is thus deſcribed. It bears, ſays the writer, a ſtriking reſemblance to a *louſe*, and when it is firſt diſtinguiſhable by the eye, is of a red colour, nearly reſembling that of a boiled lobſter, and ſo ſoft and tender as to be killed by the ſlighteſt preſſure; as it increaſes in ſize, the colour gradually changes from red to a dirty black, when it becomes ſtationary, and continues ſo till it dies. During its growth, it alſo loſes this ſoft tender texture, and in its black ſtate feels hard, and as if it were covered with a cruſt or ſhell upon the back. It does not appear that this is a new inſect, for moſt of the farmers with whom the writer has converſed ſeem well acquainted with it, and all of them aſſert, that, if they are carefully looked for, ſome of them may be met with, even in the beſt fields of wheat, every year. It appears, however, that they are infinitely more numerous and deſtructive in late wet ſeaſons, than in ſuch as are earlier and more favourable. In the year 1782, for inſtance, when the crop was uncommonly late, and the ſeaſon very wet and cold throughout, the wheat crop, he ſays, almoſt entirely failed from the depredations of this inſect; and every other inſtance that can be recollected of their miſchievous effects, has always taken place in the lateſt and coldeſt ſeaſons. The obſervations

every caſe done to ſuch crops as have not been perfectly covered after ſowing, or when the ſeed is very near the ſurface, while ſuch as are depoſited to a greater depth almoſt wholly eſcape, it is ſuggeſted, that, by depoſiting the grain more deeply in the ſoil, and covering it in a more perfect manner, as by drilling or dibbling, much may be effected in the prevention of this malady.

Others, however, conſider the diſeaſe as a fungus of the linear, oblong, tawny, black kind, that attaches itſelf to the ſtems of the wheat plants at the period when the grain is nearly ripe, in ſuch ſeaſons as are very moiſt, affording a ſooty appearance to the crop. It is aſſerted, that the ſtems are apparently ſplit, and the growth of the plants greatly impaired and reſtricted *. The author of Phytologia ſuppoſes it to be a malady in ſome meaſure ſimilar to the *rubigo*, or *ruſt*, a diſeaſe that attacks particular plants that are previouſly in an unhealthy condition, and which may probably be prevented, or remedied, by the expoſure of them to more light, and a greater degree of ventilation, as in the mildew or white *mucor*.

Some alſo aſſert the cauſe of this affection to be a vitiated ſtate of the juices of the vegetables proceeding from obſtruction, induced by ſudden alternations of heat, cold, and moiſture, without ſufficient ſun to cauſe the abſorption of the latter, in conſequence of which inſects are generated in the plants, and their growth thus injured; and, on theſe grounds, adviſe ſimilar modes of removing it

which he made a few ſummers ago confirm him in that belief: for he uniformly found that, in proportion as a field of wheat was early, the injury done was not only much leſs, but the number of vermin ſmaller; while, on the contrary, as the crop was later the miſchief was in the ſame proportion greater, and continued ſo throughout the ſeaſon. The inference he draws from thence is, that wet ſeaſons are more favourable to the generation of theſe inſects than dry ones, and that though they are bred in conſiderable numbers even in the beſt years, yet they come into exiſtence at a period of the ſeaſon when the crop is too far advanced to be injured by them. This laſt idea was conſiderably ſtrengthened by trials which he lately made, of placing the inſects upon healthy plants at different periods of their growth: when put upon plants in the flower, and while the ſtalks and blades were green and tender, they adhered firmly, and completely effected the deſtruction of the ear; but when put upon ſuch as had made ſome progreſs towards filling the blades, and the ſtalks of which were beginning to harden and become tough, they not only entered upon them with more difficulty, but if the growth and filling had advanced beyond a certain period, and the blades, &c. had loſt their ſaccharine taſte, they would not remain upon them; or if they did, they died, ſeemingly of hunger. He tried them upon ſeveral hundreds of healthy ears in this way, and with the ſame reſult; from which he thinks it is at leaſt preſumable, that a certain degree of hardneſs in the ſtalks and huſks of the wheat is a ſufficient protection againſt this inſect; and that after the grain has paſt the milky ſtate, it is beyond the reach of being injured by them.

* Lambert, in Tranſactions of Linnæan Society, vol. IV.

to thoſe that have been mentioned above *. It is well obſerved that the blights occaſioned by froſt generally happen in the ſpring, when cold nights ſucceed to warm ſunny days, as the living power of the plant has then been previouſly exhauſted by the ſtimulus of heat; and is therefore leſs capable of being excited into the actions which are neceſſary to vegetable life, by the greatly diminiſhed ſtimulus of a freezing atmoſphere. But whether the malady originate from inſects, the action of other plants, a corrupted ſtate of the vegetable fluids, or ſome peculiar defect in the vegetative proceſs of the plants, it is probable the beſt mode of preventing or removing it will be the expoſure of the plants as much as poſſible to the influence of the air, by ſowing the grain with larger ſpaces, or thinning them out, when too thick and cloſe, by the hoe, in the later ſpring months, when the ſtate of the crop is fully aſcertained. That ſuch methods may be beneficial, is clearly ſhewn by the general obſervation, that hilly diſtricts are much leſs expoſed to the diſeaſe than ſuch as are low, flat, and confined.

The *blaſt* is an affection of vegetables that proceeds from lightning, or the intenſe action of the ſun, when the plants are in a ſtate of conſiderable aptitude for the action of ſtimuli. It is the moſt common in hot climates; but Dr. Darwin, from having found that extenſive wood-cutters often find trees cracked on being ſawn through, ſuggeſts lightning as a more frequent cauſe of the diſeaſe in this country than is commonly ſuppoſed. The effects of theſe cauſes on wheat crops have been noticed by Tull, and deſcribed as occurring in blackiſh patches in different parts of the fields. As the vital power of the plants is moſtly, in theſe caſes, either completely exhauſted by the great and ſudden operation of ſuch ſtimuli, or their vaſcular ſyſtem deſtroyed by their expanſive action, no remedy can be of any great utility †.

The *uſtilago*, or *ſmut*, is another vegetable diſeaſe to which wheat and other grain crops are often expoſed, and in which a ſort of black meal is produced in the place of ſeed. It has been aſcribed to many different cauſes by writers on agriculture. It is remarked in the Memoirs of the Bath Agricultural Society, that this is a diſeaſe that only occurs when the weather is wet during the period of flowering, in which the *anthers* may burſt, and the *farina* be waſhed away. The diſeaſe is there ſuppoſed not to be produced by any infectious ſubſtance, or the ova of inſects that may adhere to the grain, as ſmutty ears and ſound ones were found proceeding from the ſame root, and, in ſome inſtances, both ſmutty

* New Farmer's Calendar, p. 408.

† Darwin's Phytologia, p. 332.

and found grains to be contained in the ſame ear; ſome of the corns having even one end ſmutty and the other ſound. It is therefore ſuppoſed to ariſe in conſequence of the want of due impregnation, from the *farina fecundans* being faulty, and that putrefaction takes place on the death of the corn. This opinion is ſupported by the experiments of Spallanzani, who diſcovered that the ſeed is produced in the plants long anterior to impregnation, which cannot be performed until the flower is open, and the duſt of the anther fully ripe.

On theſe grounds, it is conceived that, for want of impregnation, or the vivifying principle, the wheat corn may putrify, as is the caſe with the addle eggs of oviparous animals*.

The enquiries of a writer who ſeems to have paid much attention to the ſubject, are, however, highly in favour of the opinion, that the malady is produced by the attacks of an inſect; and that, though unqueſtionably infectious, it may be prevented, or cured, by the uſe of different kinds of ſteeps, ſuch as have been already deſcribed †. Others have likewiſe ſuggeſted that ſteeps, prepared with aloes, tobacco, and hellebore, may be uſeful for the ſame purpoſe, when applied during the growth of the crop, by means of a piece of flannel immerſed in them, and drawn different ways of the ridges, by two perſons walking in the furrows, ſo as to touch the ears ‡. The proper time of performing this buſineſs is when the weather is fine and dry ‖.

* Darwin's Phytologia, p. 323.

† Communications to the Board of Agriculture, vol. II. p. 226. ‖ Ibid.

‡ The facts and obſervations on which theſe concluſions are founded, are detailed in the following manner by Mr. Somerville, in the ſecond volume of Communications to the Board of Agriculture. Some years ago, he ſays, he collected a quantity of ſmutted ears from one field of wheat, in which they were very numerous, and a number of healthy well-filled ears from another field, in which there was no ſmut. The grains were rubbed out of both, intimately mixed, and kept in a box for two months, at the end of which they were rubbed between the hands in ſuch a manner as to break the whole of the ſmut ball. The parcel was then divided into two equal parts, one of which was three or four times waſhed with pure water, and well rubbed between the hands at each waſhing, and afterwards ſown in a drill in his garden; the other half was ſown in another drill without any waſhing or preparation whatever; the ſoil and every other circumſtance was equal. Both parcels vegetated at the ſame time, and for about two months thereafter there was no viſible difference in their appearance; about that period he, however, obſerved that many of the plants in the drill, that had been ſown without being waſhed, were of a darker colour than the others; theſe, when narrowly examined, were of a dirty green. The plants in the drill that had been waſhed were all of one colour, and ſeemingly healthy; as the ſeaſon advanced, the difference in colour became more ſtriking, and continued to increaſe till the grain was fairly out of the blade; about which time many of the dirty green ears began to exhibit ſymptoms ofdecay. As ſoon as the ear was fairly ſhot out, the whole of thoſe in the un-

But though theſe methods may be employed in order to prevent the propagation of the diſeaſe, it is probable that it can only be effectually guarded againſt by ſowing the ſeed in ſuch a manner as to admit of a perfectly free circulation of air among the plants, and of thoſe modes of after-culture that are adapted to promote their healthy and vigorous growth.

waſhed drill, that had the dirty green appearance above deſcribed, were found to contain nothing but ſmut; and theſe ſmutted ears were in the proportion of more than ſix to one of the healthy ones: while, on the contrary, the drill in which the waſhed grains had been ſown, and which conſiſted of ſeveral hundred grains, had hardly a ſmutted or unhealthy ear in it. The ſame experiment was repeated the following ſeaſon, and with nearly the ſame reſult. Satisfied with knowing that complete waſhing would be found a remedy for the diſeaſe, he made no farther enquiry upon the ſubject till laſt autumn, when he was employed in making obſervations upon the blight, in the courſe of which he met with a good deal of ſmut in many fields; and being at the time poſſeſſed of ſome excellent glaſſes, he carefully examined ſome of the ſmutted plants. This at firſt was done more as a matter of amuſement, than from an expectation of diſcovering any thing that might contribute to throw light upon the ſubject. Upon a near inſpection with the glaſs, he found that the dirty green colour of the blades of the ſmutted ears was owing to a number of ſpots infinitely ſmall, and bearing a near reſemblance to thoſe upon blighted ears: his obſervations were continued throughout the whole period of the ripening, in the courſe of which he made no additional diſcovery, except obſerving, that the leaves and ſtalks of the ſmutted ears decayed ſooner than ſuch as were healthy.

About the end of autumn, however, having one day brought home ſome ſmutted ears of rather an unuſual appearance, he examined them very narrowly, and obſerved that the balls were perforated in many places with ſmall round holes, a thing he had not before obſerved in any that he had met with: this he aſcribed to vermin; and upon ſticking one of the grains upon a pin, and placing it under the glaſs in a very bright ſun, he could diſtinctly obſerve ſeveral ſmall tranſparent ſpecks upon the beard, or downy part of it. He examined ſeveral more, and met with exactly the ſame appearance; but being called haſtily away upon buſineſs, he was under the neceſſity of leaving them upon the table, without being able to aſcertain whether the objects he had ſeen were eggs or inſects. In the evening when he came home, he reſumed the inveſtigation by *candle-light;* in the courſe of which, as he was under the neceſſity of holding them very near the candle, the heat ſoon relieved him from his embarraſſment, by putting them in motion, and he then diſcovered that the ſpecks above mentioned were real inſects, reſembling wood-lice in ſhape. Next day he repeated the ſame trials by ſun-light with new ſmut-balls, and diſcovered the ſame appearances, but without being able to make any of the inſects ſtir. Diſappointed and vexed at not being able to ſee them in motion with ſun-light, and recollecting the heat of the candle, he threw the concentrated rays of the ſun upon them with a burning-glaſs, which completely anſwered his purpoſe of putting them in motion, and ſhewing them in every different point of view. To deſcribe minutely an inſect ſo ſmall as not to be diſtinguiſhable by the naked eye, would, ſays he, be no eaſy matter; it is ſufficient to ſay, that its general appearance is very ſimilar to the wood-louſe, though infinitely ſmaller.

As ſoon as he was clearly aſcertained of the exiſtence of this inſect, his mind was, he ſays, perfectly at eaſe with regard to the cauſe of the diſtemper; but though he could very readily conceive

It has been ſuggeſted that grain diſcoloured with the ſmut may be readily rendered proper for ſale by waſhing and drying it upon a malt kiln, as the ſound corn is ſome time in ſaturating itſelf with moiſture. Sand may alſo be uſed for the ſame purpoſe, which, after being mixed and well agitated with the grain, may be ſeparated by means of a ſieve *.

There are particular ſtates of the weather that have conſiderable influence on the wheat crops at particular periods of their growth. When the ſeaſon is ſufficiently dry, there is ſeldom much injury done to them during the winter months, however ſevere they may be in other reſpects; nor in thoſe of the

that vermin, in the early ſtages of the growth of a plant, might ſo injure the ſtamina as to render it unfit to produce any thing but ſmut, he could not ſo well underſtand how it was poſſible for the mere touch of the black earth contained in the ſmut-balls to produce the ſame effect.

After ſome reaſoning he, however, gives it as his opinion that ſmut is occaſioned by the ſmall inſect above deſcribed, as ſeen by the glaſs in the downy part of the grain; and that when the balls are either broken in the operation of thraſhing, or come in contact with clean healthy grains, the inſects leave the ſmutted grains, and, adhering to ſuch as are healthy, are ſown with them, and wound the tender ſtem in ſuch a manner as to render the plant incapable of producing any thing but ſmut. It is not an eaſy matter to account for the manner in which this takes place; but a little attention to the circumſtances he is now to mention will perhaps throw ſome light upon it. It is known that plants of very oppoſite *natures* and *qualities* will grow and produce abundantly upon the ſame ſoil, where the nouriſhment is ſeemingly the ſame. This effect is alſo known to be owing to the ſtructure of their veſſels, by the action of which the juices that circulate through them are differently prepared in every different plant. From this ſtriking difference, owing confeſſedly to organiſation, is it not, ſays he, preſumable that the ſmut in wheat is produced by the inſects wounding the veſſels of the plant in ſuch a manner as to render them incapable of taking up any other principle from the ſoil, but the ſmut contained in the balls, which upon examination ſeems to have no quality different from the fineſt vegetable earth? This opinion he thinks is ſtrongly ſupported from the circumſtance of certain *pickles* being found a cure for the malady. The effect of theſe pickles is, however, completely miſunderſtood; for in place of ſuppoſing, as is erroneouſly done, that they operate by ſtrengthening the grain, and thereby removing that debility which has been long conſidered as the cauſe of ſmut, their benefit depends upon the powers they poſſeſs of deſtroying the inſects above deſcribed: but to ſhew the abſurdity of the commonly received opinion in a more ſtriking point of view, it is only neceſſary, he adds, to ſtate, that many of theſe preparations, which are ſuppoſed to be ſo friendly to vegetation, are in fact highly inimical to it, unleſs they are uſed with the utmoſt caution; even ſtale urine, which has long been conſidered as a ſafe and innocent remedy, is, under certain circumſtances, highly pernicious. After he had diſcovered the inſect, he made trial of all the ſubſtances commonly uſed, and found all of them, when properly applied, deſtructive to it. Is it not therefore, continues he, more agreeable to plain common ſenſe to ſuppoſe, that the virtue of theſe preparations conſiſts more in the power they have of deſtroying vermin, than in any ſtrengthening quality they poſſeſs?

* Phytologia, p. 323.

ſummer, provided the weather is not too moiſt about the blooming ſeaſon, as where that is the caſe the crops are moſtly deficient *.

There are ſeveral different ſorts of weeds that become injurious to wheat crops, where they have been put in upon lands in an imperfect ſtate of preparation. On the lighter kinds of ſoils, eſpecially thoſe of the calcareous deſcription, *charlock* † is often extremely troubleſome. It is a weed that bears a yellow flower in ſome of the kinds, and a white one in the other, and is not therefore one individual plant, as generally ſuppoſed by the moſt part of farmers, but three diſtinct ſpecies, each of which is prevalent in different places. Theſe are the rough-leaved charlock, or wild muſtard; the ſmooth-leaved, or wild rape; and the rough-leaved wild radiſh having white flowers ‡. They are all annual plants, ariſing from ſeeds which they afford in great abundance, and which, if ſuffered to be ſhed upon the land, remain for a great number of years enveloped in the clods, in a condition fit for vegetation on expoſure to the influence of the air, and a ſuitable degree of moiſture, by means of ploughing, or any other method of breaking up and reducing the ſoil. Such plants ſhould, of courſe, never be permitted to run to ſeed, but be extirpated in their young ſtate, either by hoeing or ſome other means; as, by attention in this way, much inconvenience may be avoided, as the increaſe by ſeeding is hardly to be conceived. Bindweed is alſo a weed of the paraſitical ſort, that is highly injurious to wheat crops on this ſort of land. It is of two kinds, the common and the black ‖, and may be removed with greater eaſe than the above, by affording ſufficient tillage.

The *corn poppy* § is another weed that is often injurious to theſe crops on the chalky ſorts of land. It moſtly makes its appearance about May, proceeding with ſuch rapidity in its growth, both in height and laterally, as ſoon to overtop the grain, and deſtroy the crop, by the ſhade that it produces, the corn being rendered thin and defective in the ear. In theſe caſes it is the cuſtom of ſome diſtricts to obviate the miſchief by eating the weeds in the early ſpring, as about May, by hogs, which are ſaid to be ſo particularly fond of the plant as to devour it with avidity, and in preference to the young wheat ¶. The practice

* Synopſis of Huſbandry.

† It is often, beſides this, known by the different names of *cadlock, kitlock, kilk,* in particular diſtricts.

‡ The *ſinapis nigra,* the *braſſica napus,* and the *rephanus raphaniſtrum,* of botaniſts.

‖ The *convolvulus arvenſis,* and the *polygonum convolvulus,* of botaniſts.

§ The *papaver rhoeas* of botanical writers.

¶ Synopſis of Huſbandry, p. 78.

ſeems, however, dangerous, and a better and more ſafe remedy is at hand in due tillage of the land, and the early extirpation of the plants by the hoe.

Cockle * is likewiſe a weed that often proves hurtful to crops of wheat. It is of great increaſe, frequently ſending off ſeveral ſtems from the ſame root, each containing many pods filled with ſeed. It uſually blows about June, with a pink-coloured bloſſom, and may then be eradicated without much difficulty, by pulling up the plants as they come up. There are two ſorts of this weed, the common and ear cockle. The latter, according to a late practical writer, varies from the former, in being conſiderably ſmaller in ſize, and by its peculiarity of growing within the ear of the wheat plant; in ſome inſtances the whole ear affording no other produce than this, while, in others, one part of it contains perfectly formed wheat, and the other ear-cockle. It is aſſerted, on the authority of much obſervation, to be a degeneracy in the wheat, from its being too frequently ſown on the ſame land from which it was produced †. If this be the fact, the remedy muſt obviouſly conſiſt in a frequent change of ſeed. It is, however, more probable that this weed is produced by ſowing the ſeed with the wheat, and may of courſe be prevented by care in ſowing clean wheat.

White darnel ‡ is another very prolific weed that does much injury to wheat crops, both during the time of its growth, and when at market, by ſpoiling the ſample. It is an annual plant, the ſtem of which has a ſlight reſemblance to that of grain, and may probably be beſt prevented by attention to the putting in ſuch ſeed wheat as is perfectly clean. Where it occurs, the ſafeſt method is to draw it out by the hand.

Puck-needle ‖ is a weed that is often abundant on ſuch lands as are hard tilled, and almoſt equally injurious with the above in leſſening the value of the ſample at the market. As the ſeed of this weed is not eaſily ſeparated in cleaning the corn, much care is always neceſſary in order to prevent its being ſown with the ſeed.

Couch, or what in many diſtricts is better known by the name ſquitch, is a weed that is highly injurious to wheat crops, and extremely difficult and expenſive in its removal to the cultivators of ſuch arable lands as thoſe deſcribed above. It does not comprehend the roots of any one particular, but of ſeveral ſorts of peren-

* The *agroſtemma githago* of writers on botany.

† Banniſter's Synopſis of Huſbandry.

‡ This is the *lolium temulentum* of botaniſts, and is often known to farmers by the names of *drake* or *droke*.

‖ The *ſcardix pecten veneris* of botaniſts, and what is often known to agriculturs by the names of Shepherd's needle, Beggar's needle, &c.

nial graſſes, eſpecially thoſe of the bent kind, the dog's graſs, the creeping ſoft graſs, the tall oat graſs, &c. * The roots of theſe different graſſes are not unfrequently, in ſuch lands as have been exhauſted and worn out by improper tillage, ſo interwoven with the ſoil, and in ſo matted a condition, as to obſtruct the progreſs of the plough. They are found to be moſt abundant in the lighter and more mixed kinds of ſoil. Weeds of theſe kinds are only capable of being completely removed and deſtroyed by having them drawn out, while the land is under fallow, by means of heavy harrows conſtructed for the purpoſe, with a greater number of teeth, or tines, than is neceſſary for thoſe of the common ſort, and placed ſo as to incline more forward. When brought into heaps in this way, they may either be conſumed by fire, or reduced into a compoſt, by the incorporating of lime, in its unſlaked or moſt cauſtic ſtate, with them, and afterwards adding dung, or rich mold, in a ſuitable proportion. The latter is by much the moſt economical method when lime can be readily procured, and is not attended with much trouble, as ſuch compoſts may be formed in the corners or other parts of the fields where the weeds are produced. The uſual method of picking out the roots by hand labour, which is termed *couching*, is not only tedious and expenſive, but ſeldom effectually performed. The well-known property of theſe roots to propagate and encourage different ſorts of grubs, worms, or other inſects, affords a ſtrong inducement to effect the deſtruction of ſuch root weeds by every poſſible means, eſpecially where wheat crops are to be grown.

Beſides theſe weeds, there are others that are equally hurtful to wheat crops in lands that have not undergone a proper preparation by tillage, and are rather ſtrong and moiſt, ſuch as the corn-crowfoot, the tare, &c. †. In grounds where the latter predominates, care ſhould conſtantly be taken to deſtroy it, by reducing them into a ſtate of fine tilth before the wheat is put in.

Coltsfoot ‡ is a weed that, in ſoils of the moiſt and rather heavy kinds that have been conſiderably exhauſted by tillage, is liable to become troubleſome, and of great diſadvantage to the wheat crops. As this weed begins to ſhew its flower towards February and March, and ſoon afterwards ripens its ſeeds, it ſhould not by any means be neglected at ſuch periods, as from the levity of them, and their downy nature, they are quickly conveyed to a diſtance, by which means they ſoon eſtabliſh themſelves in different places. Repeated ploughings

* The *agroſtes*, the *triticum repens*, the *holcus mollis*, and the *avena elatior* of botanical authors.

† The *ranunculus arvenſis* and *croam tetraſpernam* of botaniſts.

‡ The *tuſſilago farfara* of writers on botany.

during the ſummer ſeaſon, by rendering the ſoil light and mellow, may render them capable of being more readily extirpated by weeding. And as they delight in moiſture, laying the ſoil more dry by the forming of proper drains may alſo be of great utility. But from the roots of the plants ſpreading themſelves extenſively near the ſurface of the land, they will conſtantly require to be completely extirpated.

Wheat is known to be ripe and ready for the reaper, by its ſtraw turning of a yellow colour, its ears beginning to bend in the neck and hang down, their having no greenneſs in the middle of them, and the grain becoming hard and plump. The quantity of wheat produced upon the acre muſt vary conſiderably, according to the circumſtances of ſoil and preparation, as well as the ſtate of the ſeaſon; for it has been found, that ſome years the yield is under twenty while in others it is upwards of thirty buſhels the acre, the ſoil and culture being in every reſpect the ſame *. The average return of this crop throughout the whole of the kingdom, is probably not more than from three to three and a half quarters. A practical writer has, indeed, ſtated it at not more than three †.

In Middleſex, the greateſt crop of wheat of which the author of the Report of that diſtrict has any account, is, he ſays, ſixty-eight buſhels per acre; the leaſt about twelve. The medium between theſe extremes is forty, which, he thinks, would be the average of land highly conditioned. But the average produce of Britain does not, he ſuppoſes, exceed one half of this quantity, and yet, ſays he, wheat is as certain a crop as any that is cultivated ‡. This, he thinks, affords a clear proof that "the lands of England are reduced conſider-

* Corrected Report of Middleſex.

† Donaldſon's Modern Agriculture, vol. II. p. 276.

‡ According to Mr. Middleton, "the proportion which corn bears to the ſtraw in that diſtrict, is nearly as follows; namely,

The yield of	1793	was $17\frac{1}{2}$	buſhels of wheat to a load of ſtraw;
	of 1794	$8\frac{1}{8}$	ditto;
	of 1795	11	ditto;
	of 1796	$9\frac{3}{8}$	ditto.
The medium of four years		$11\frac{1}{2}$	ditto.

Straw ſold during the ſame period from 25*s.* to 40*s.* per load. The load conſiſts of 36 truſſes, at 36lbs. per truſs. Two loads of wheat ſtraw per acre is reckoned a tolerable crop, which may be averaged at eight pence a truſs, or 24*s.* a load, or 2*l.* 8*s.* per acre. In other parts of the kingdom, the

ably below par, which," in his opinion, " can only have happened by a too frequent repetition of corn crops, and general bad management, which has of courſe leſſened the *quantity* of *live ſtock*, and with that, the beſt means of raiſing *manure*. Let farmers," continues he, " be induced to ſow crops to be eaten on the land by cattle, ſo that they may there leave their dung and urine, and corn will then be grown in double quantity; and the live ſtock, ſupported by ſuch green crops, be clear gain to the community."

In order to aſcertain the goodneſs of a ſample of wheat, it is neceſſary to judge by the eye whether the *berry* be perfectly fed, or full, plump, and bright, and whether there be any adulteration proceeding from ſprouted grains, ſmut, or the ſeeds of weeds; and by the ſmell, whether there be any improper impregnation, and whether it has been too much heated in the mow or upon the kiln; and finally, by the feel, to determine if the grain be ſufficiently dry, as when much loaded with moiſture it is improper for the uſes of the miller. Where the ſample handles coarſe, rough, and does not ſlip eaſily in the hand, it may be decided not to be in a condition either for grinding or laying up in the granary. The ſame means may alſo ſerve to determine the weight; but conſiderable experience is neceſſary to decide with much correctneſs. It is obſerved by the author of the Synopſis of Huſbandry, that " it is a good ſample of wheat where the weight of a ſack, at eight gallons the buſhel in meaſure, arrives at four buſhels three and a quarter pecks in weight, or 2 cwt. 1 qr. 18lb. If," continues he, " a ſack of this meaſure weigh half buſhels and quarter, the ſample is not bad, which is 2 cwt. 1 qr. 4 lb." In the technical language of the farmer and miller, it is uſual, he adds, " to drop the buſhels, and mention only the odd weight; thus, in the firſt inſtance the wheat weighed three pecks four, and in the latter half buſhels four. If there are no odd pounds, it is ſaid to weigh half buſhels, or if from large meaſure the weight comes to 2 cwt. 2 qr. then it is ſaid to weigh five buſhels."

Rye.—This is a ſpecies of grain which probably approaches neareſt to the nature of wheat of any that is at preſent in cultivation. It has two varieties, the *winter* and *ſpring* rye, or what is often farther diſtinguiſhed into the *black*, and *white* or

value of the ſtraw is ſuppoſed equal to nearly the expence of reaping. Perhaps at an average of 30s. (it has lately been as high as 3*l.* 12*s.*) which is on the corn, equal per buſhel to - £. 0 2 7

Short ſtraw and chaff - - - - - -	0	0	1
Wheat, at an average price for many years - - -	0	5	6
The entire produce of wheat per buſhel, is full - - £.	0	8	2

The weight of the wheat grown in the ſtrong land diſtrict, is uſually 61 or 62lbs. per buſhel."

Dantzic rye. The former ſort is the largeſt, and the moſt plump and hardy, conſequently the moſt frequently grown by agricultors; but the ſpring kind may often be employed with ſucceſs. This grain is ſo capable of reſiſting the effects of the weather, that, when ſown in the autumn, it is ſeldom much injured by the moſt ſevere winter. It is more early in the ſpring than wheat, and, though not equally valuable, is more certain of producing a good crop.

This ſort of grain is capable of being cultivated on moſt kinds of land, but the light dry ſandy ſoils that cannot be converted to the purpoſe of wheat or barley crops, are, perhaps, the only ones on which it can be grown to advantage, from their being the moſt adapted to it, and from few of them being ſo light or poor as not to afford good crops. It can of courſe only be introduced with ſucceſs on ſuch lands as are incapable of producing other ſorts of corn to advantage, and where the improved methods of cultivating wheat crops have not been had recourſe to. Even upon ſome of the pooreſt ſorts of ſandy ſoil, wheat is ſuppoſed in ſome diſtricts to be grown with more benefit to the cultivator, the quality of the land being the ſame, than this grain *. And from fowls being leſs fond of it than moſt other ſorts of grain, it may be the moſt proper to be cultivated on thoſe portions of ground that are ſituated cloſe around the farm houſes.

It is a kind of crop that is moſtly grown after early-fed turnips, clover, peas, and other ſimilar products, as well as after naked fallows, in particular caſes. When cultivated on the cold and heavy kinds of ſoil, the grain is much later in becoming ripe than on ſuch as are dry and light.

This crop, like that of wheat, requires the land to be in a tolerable ſtate of pulveriſation, and perfectly cleared from weeds. In many diſtricts, when intended to ſtand for a crop, it is the cuſtom to put it in upon ſome ſort of fallow; but where it is only to be fed off by ſheep, ſeldom more than one ploughing is given, the land being broken up and fallowed for turnips immediately after the crop has been ſufficiently eaten down by ſheep or other animals. It is the practice in ſome places to apply manure immediately for this crop; but where the ſoil is in a ſuitable ſtate of preparation, and has not previouſly been too much deteriorated by the growth of other grain crops, it may be more adviſable, eſpecially where it is not to be fed off, to defer the application of the manure, in order that it may be employed for the turnip or other green crop that may ſucceed it, the uſe of manure being apt to bring up weeds.

* Young's corrected Report of Suffolk, p. 57.

Time of ſowing.—The periods of putting this kind of crop into the ſoil are, in general, pretty much the ſame as thoſe of wheat; but when cultivated for green food, it may be advantageous to ſow early, as in Auguſt and September; but it may be ſown in October, and during the winter months, until the beginning of March, in particular caſes, as where the early ſowings have failed, or there is an intention of having a ſucceſſion of this ſort of feed for ſheep.

Seed.—The general allowance of ſeed, where the crop is deſigned to remain for grain, is in moſt ſituations from about two buſhels to two and a half; but when the intention is to feed it off, three, or even more, may be a better proportion, as the plants in ſuch caſes ſhould ſtand conſiderably thicker upon the ground, in order that the largeſt poſſible quantity of green food may be provided. As the proceſs of germination in this ſort of grain is rather ſlow, it may be adviſable to put it into the ground when it is in a tolerably dry condition, otherwiſe much of it may periſh, eſpecially in wet ſeaſons.

It was formerly a prevailing cuſtom to blend ſeveral other ſorts of ſeed with that of rye, and the practice ſtill continues in ſome diſtricts in reſpect to wheat and winter tares; but it is by no means either judicious or uſeful, ſince, in the firſt caſe, the rye is in a ſtate fit for reaping long before the wheat, conſequently much loſs muſt be ſuſtained; and, in the latter, it is moſtly in a condition to be cut as green food ſome weeks before the tares, and becomes ripe at much too early a period for them *.

Where wheat is combined with rye, it is in many diſtricts termed *meſlin*, the proportion of the latter to that of the former being regulated by the nature of the ſoil, and the judgment of the cultivator, the principle being that of giving the largeſt proportion of rye to the lighteſt kinds of ſoil †.

After-culture.—When this ſort of crop is grown for the purpoſe of the grain, it will be conſtantly neceſſary to keep it clean in the early ſtages of its growth by hand weeding and hoeing, when they may appear requiſite; but where the intention is merely that of affording a ſupply of green food for the uſe of ſheep or other animals in the more early ſpring months, no further culture will be wanted after the crop has been put into the ground.

This ſort of crop is known to be ready for the ſickle by the ſtraw of the ſtems becoming of a yellowiſh colour, the ears hanging down, and the grain feeling hard, and in a plump and full condition.

* Modern Agriculture, and Corrected Report of Middleſex.

† Corrected Report of the North Riding of Yorkſhire.

In the poor ſandy ſoils of Suffolk, good crops of this ſort are ſeldom afforded, and on thoſe of a better quality the produce is rarely more than from two to three quarters on the acre. But in the north riding of Yorkſhire, it is ſtated by the able author of the Agricultural Report of that diſtrict, to amount to from three to ſix quarters.

When this ſort of grain is free from weeds, and cut when the weather is fine, it may be ſecured in the ſtack as faſt as the reaping proceeds.

The ſtraw of this grain is ſuperior to that of wheat, both for the purpoſe of thatch, and for the uſe of the collar-makers.

This is a kind of grain that is alſo cultivated in particular caſes, as where the ground is ſufficiently light and dry, to be turned down as a manure; when this is the caſe, the crop ſhould always be turned in while in its moſt green and ſucculent ſtate, and when the weather is moderately dry, in order that it may be more quickly reduced by the proceſs of putrefaction.

It is ſometimes the practice of farmers, when rye is intended to ſtand for a crop, to feed it with ſheep in the early ſpring, as in the beginning of March; but this ſhould never be done except where the crop is very luxuriant, and at ſo early a period as that there may not be any danger of deſtroying the new-formed ear.

In the ſouthern parts of the kingdom it is alſo often cultivated for the uſes of thoſe engaged in the buſineſs of tanning leather; but more frequently as a green food for ſheep in the ſpring, before the turnip crops are ready. When grown in this view, it is neceſſary to have attention to different circumſtances, in order to derive the utmoſt advantage from the crops. As this grain begins to ſhoot out, or ſpindle, as it is termed by farmers, much earlier than wheat, care, as has been juſt obſerved, ſhould be taken that the feeding of it down is begun at a ſufficiently early period before the ear is formed in the *hoſe*, as the latter end of February or beginning of March; otherwiſe the ſtem or blade becomes firm and ſticky, and the ſucceſſion of green feed, after the firſt eating, extremely ſmall. Indeed this may be done earlier than the firſt of theſe periods, in caſes where the ſeaſon is mild and open, and perſevered in till the end of April. In all caſes it is, however, adviſable to let the crop be ſo advanced in its growth as to cover the ground tolerably before the ſheep are turned in. As this ſort of green food is ſaid to have much effect in promoting the flow of milk in ſuch ewes as have lambs, probably from its ſucculency, and its ſtimulant properties being applied immediately after the ſeverity of the winter ſeaſon, when the bodies of animals are known to be more capable of being excited by the action of ſtimuli, and when there is

ſcarcely any other ſort of green feed that can leſſen its operation by being taken along with it, the culture of it muſt be the moſt advantageous where ſheep-huſbandry is extenſively combined with that of tillage, eſpecially that department of it which relates to the feeding of lambs; as by this means, from the quantity of ſucculent nutritious food that is provided, the lambs are prevented from being ſtinted in their growth while young, which is a matter of the utmoſt importance in their future feeding.

In feeding this ſort of crop off by ſheep, it will likewiſe conſtantly be neceſſary to keep the fields properly divided by means of hurdles, as in this way the loſs of food will be much leſs, and ſome parts will become freſh while the others are eating down.

Barley.—This is a much leſs hardy ſort of grain than either of thoſe that have been deſcribed; but from its great utility in the compoſition of malt liquors, and in the preparation of various kinds of ſpirits, it is extenſively cultivated in ſuch diſtricts as, from the nature of their ſoils, are adapted to its growth. It may, indeed, be conſidered as the next grain in value to that of wheat.

There are ſeveral kinds of this grain cultivated in particular parts of the kingdom; as the *ſpring* or common *barley*, the *long-eared barley*, the *ſprat* or *battledore barley*, the *bear* or *ſquare barley*, and the *big barley*. The firſt ſpecies of barley is grown pretty extenſively in the ſouthern as well as the eaſtern parts of the iſland; and the ſecond, or long-eared ſort, may frequently be met with, but from the great length and weight of its ears, it is more apt to lodge, conſequently is more hazardous than that of the common or ſpring kind. The ſprat or battledore ſort is broader in the ear than any of the others, and has at the ſame time a ſhorter and more tapering ſtem, with erect ears, on which accounts it is leſs diſpoſed to lodge or fall to the ground. It is often diſtinguiſhed by the title of Fulham barley, from its having been extenſively cultivated in the neighbourhood of that place. The *bear* or four-rowed barley, and the *big* or ſix-rowed barley, are grown to conſiderable extent in the north-weſtern parts of England, as well as in Scotland. Theſe are winter barleys, and require to be put into the ground in the autumnal ſeaſon, ſomewhat in the manner of wheat.

From the tender and delicate nature of this ſort of grain, eſpecially in the more early ſtages of its growth, it is incapable of being cultivated with advantage on the ſtiff, heavy, and wet deſcriptions of ſoil, or ſuch as are of a cold and tenacious quality. It is ſaid to grow in the moſt perfect manner in a loamy ſand, or ſuch ſoils as are moderately dry and ſufficiently light. The moſt plump and

thinneſt-rinded grain is aſſerted to be produced on ſuch lands as are dry, light, and mellow; and theſe are the qualities that are conſidered as the moſt eſtimable. Light poor land, when dry and warm in reſpect to ſoil and ſituation, is even capable of affording barley that is much ſuperior in quality to ſuch as is grown on ſtrong lands, that are of a cold and moiſt nature.

This ſort of grain is cultivated after almoſt every kind of crop; but it has been found to ſucceed to the moſt advantage after thoſe of the green or ameliorating kind; as turnips, potatoes, carrots, peas, tares, &c. However, from the nature of grain crops, it can ſeldom be cultivated to great advantage after wheat, rye, or oats: in ſuch caſes it has generally been obſerved that the crops were blighted and imperfectly fed, even upon ſoils the moſt adapted to this ſort of grain*. Where flax, hemp, or rape, are grown, barley may ſometimes be ſown after them. When ſown after any of theſe improving crops, manure is ſeldom neceſſary; as in many of them the ſoil muſt be rendered ſuitable by the feeding of them off by animals, and in the others, from a large proportion of it being required for the growth of ſuch crops, it muſt be equally unneceſſary. If, however, a wheat or other ſort of ſtubble be choſen for the purpoſe, manure will be requiſite, which ſhould always be well mixed and incorporated with the mold before the ſeed is put in, and be in a conſiderable ſtate of reduction before it is applied.

After whatever ſort of crop this grain may be grown, as the root is extremely tender, and requires much ſupport during the firſt ſtages of the growth of the plant, from the quick manner in which the proceſs of vegetation is carried on, the ſoil ſhould conſtantly be reduced into a ſtate of much fineneſs and pulveriſation, ſo as to become properly open and porous, in order to ſecure a more certain, equal, and perfect vegetation. This is to be effected by different ſlight or ebb ploughings and harrowings, as well as by occaſional croſs-ploughing and rolling. In very wet ſeaſons, on the heavier kinds of barley land, and where there are land ſprings, it may be adviſable to plough the ground into ſmall ridglets, of about eighteen or twenty inches in width, inſtead of leaving them flat; as by ſuch means the land may be kept dry in any ſeaſon, at leaſt to ſuch a degree that by two or three dry days it may become in a condition for undergoing the operation of harrowing, in order to the ſecond ploughing; and in caſe the ſtate of the weather ſhould ſtill continue improperly moiſt, the ground on this ploughing might be ridged up in a ſimilar way until the period of ſowing, when a few days more of fine weather would be ſufficient to render

* Donaldſon's Preſent State of Huſbandry in Great Britain.

it proper to be reduced by the harrow or ſcuffle, ſo as that the ſeed might be put in; or when the land is in a more moiſt ſtate than is ſuitable for this crop, a third ploughing may be given before the ſeed is put in *. It is likewiſe ſuggeſted in the ſame work, that the uſing of the ſcuffle, inſtead of the plough, in the ſecond earth, would not only expedite the buſineſs of preparation, but be a conſiderable ſaving of expence. In ſoils that are free from weeds, it is aſſerted that ſcuffling would be equal to a croſs-ploughing, and in ſuch as are not perfectly clear from root weeds, it would be ſtill more advantageous by bringing them within the power of the harrow; at the ſame time, that it would accompliſh more than double the quantity of labour with an equal number of men and horſes, beſides leaving the ground equally ready for the harrow and the roller, previouſly to the putting in of the ſeed.

When this ſort of crop is introduced upon green fallows, ſuch as turnips, &c. it is ſometimes the cuſtom to prepare the land only by one ploughing; but a better practice is that of giving two earths, the firſt as early in the ſpring as it can be done, and the ſecond immediately before the ſeed is put in. This is the practice moſtly adopted in Norfolk, where the barley huſbandry, on turnip fallows, is, in moſt inſtances, well performed.

In ſowing this grain after peas, or other pulſe crops, it is cuſtomary in moſt diſtricts to give the firſt earth or ploughing in the autumn, which ſhould always be performed in ſuch a manner, as that the greateſt poſſible extent of ſurface may be expoſed to the influence of the atmoſphere and the action of the froſts; the ridges being at the ſame time ſo laid up, as that no injury may be produced by the wetneſs that may take place during the winter ſeaſon. The ſecond earth or furrow † is moſtly given about March, when the oat crop has been put into the ſoil. By this ploughing, two different purpoſes are effected in many caſes; the root-weeds, ſuch as thoſe of couch, and other noxious plants, may be looſened, ſo as to be more readily extirpated by the application of the harrows immediately afterwards, and the ſoil reduced to ſo fine a tilth, as that thoſe of the ſeed kind may be induced to vegetate freely, and in conſequence be more perfectly removed by the action of the plough and harrow at the period of putting in the ſeed ‡.

If this kind of grain be introduced after wheat, or other ſorts of corn crops,

* Middleton's Report of Middleſex.

† This is ſometimes termed the *ſteering* furrow in the northern diſtricts.

‡ Modern Agriculture, vol. II, p. 282.

which, as has been ſhewn, is by no means a practice to be recommended, the preparation of the land is moſtly conducted in the ſame manner as the above.

Time of ſowing.—The period of putting this ſort of crop into the ſoil muſt, of courſe, vary in ſome degree according to the nature and quality of the land, and its ſituation in reſpect to climate. In moſt of the more ſouthern diſtricts of the kingdom it generally commences about the beginning of March, but in the northern parts of the iſland it often begins a month or ſix weeks later. The largeſt quantity of ſeed is uſually ſown from the middle of March to the latter end of April.

Seed.—The proportion of ſeed that may be neceſſary muſt be different, as the ſoil is of a richer or poorer quality, and as the ſeaſon of putting it into the earth is more early or late. The nature of the crop after which it is cultivated may alſo render ſome difference in the proportion of the ſeed requiſite. Much leſs ſeed is demanded where the ſoil is rich and fertile, than where it is poor and exhauſted. Early ſowing alſo requires leſs ſeed than where a late period is adopted. It has been obſerved, that, on a medium ſoil, in proper condition, ſown broadcaſt, the proper proportion may be in March three and a half, in April four, and in May four and a half, buſhels to the acre. Such is the difference of rich ſoils, that it is ſuppoſed that it can hardly be ſown too thin; one buſhel and a half ſown early having afforded as much as could ſtand, where, if three or four had been put in, the grain would have been lodged, and of courſe greatly reduced in its value *. After turnips, and other green crops, a much leſs quantity is generally neceſſary, as ſuch lands are moſtly in a perfectly ſuitable ſtate for the reception of barley crops. As this ſort of grain is apt to come up in an irregular manner, and of courſe to become ripe at different periods, by which means the ſample often ſuſtains great injury; it is probable, that by ſteeping the ſeed for ſuch a length of time as might be ſufficient to impregnate it with a due proportion of moiſture, the proceſs of vegetation might be rendered not only more regular, but even much more expeditious. The ſeed is put into the ſoil in different methods; being in ſome caſes ſown under the furrow, and in others above it. Where the firſt practice is adopted, the ſeed furrow ſhould be very light, otherwiſe the grain may be depoſited to ſuch a depth as to greatly retard, or even prevent, much of the ſeed from coming up in proper time. When ſown on the ſurface, great care ſhould be taken that the ſeed be well harrowed into the ſoil, and ſo covered, as that the grain may vegetate, and grow up in as equal and regular a manner as poſſible.

* Corrected Report of Middleſex.

It is the practice of many diſtricts to ſow clover, and other graſs ſeeds, with this crop; but where the ſoils are very rich, and of a good quality, this method of huſbandry is improper, as much inconvenience and injury may be done to the grain by the rapid and over-luxuriant growth of ſuch crops, rendering the plants weak and imperfectly fed. On the thinner and leſs fertile ſoils, where the growth of ſuch graſſes is leſs vigorous, it may however be adopted with advantage in many caſes, as little injury will be done to the grain, while the ſtraw may be conſiderably improved in the way of fodder.

Where this mode of management is had recourſe to, the ſowing of the graſs ſeeds may be deferred for ſome time after the grain has been ſown; and when they are put in, a light harrow may be paſſed over them, and the land be afterwards well rolled.

The ſucceſs that has attended the uſe of the drill and the ſetting of grain in particular caſes, ſuggeſts the propriety of attempting ſimilar practices in the cultivation of this ſort of crop, eſpecially on the richer deſcriptions of barley ſoils, as by ſuch methods it ſeems probable that the quality as well as the produce may be greatly improved.

Though the practice of ſteeping this kind of grain before it is put into the ground is not in general uſe with farmers, it is probable, as has been juſt obſerved, that much advantage might be derived from it, eſpecially as the ſeaſon is commonly hot and dry when it is performed, from the more quick and uniform vegetation of the crop. It is likewiſe ſuppoſed by ſome agricultors, that by mixing ſoot with ſuch ſteeps the danger from inſects may be diminiſhed.

In the choice of ſeed, attention ſhould conſtantly be paid to the colour and the ſtate of the ſkin or rind of the grain; as that is eſteemed the beſt which has a pale lively bright appearance, without having the tails of the corn ſtained in any way, and which is full and plump, or what is often termed well-bodied. It is common with practical farmers to change the ſeed of barley every year or two, from the ſuppoſition that the grain becomes coarſer by the repeated ſowing of the ſame kind of ſeed. The neceſſity of this cuſtom may, however, probably ariſe from the neglect of making uſe of ſuch ſeed as is full-bodied and perfectly fed and ripened.

After-culture.—As this ſort of crop is moſtly ſown broadcaſt, it ſeldom receives any improvement by culture afterwards. It is obvious, however, that by occaſionally ſtirring and looſening the mold about the roots of the plants, and keeping them clean and perfectly free from weeds, much advantage might be obtained in many caſes in the cultivation of this ſort of grain; as it may thereby

be rendered not only more abundant upon the ground, but the ſample be conſiderably improved.

When the ſeaſon turns out dry and unkindly in the early ſpring months, this ſort of crop is often much injured by the attacks of the worm; which is obvious from the ſudden change in the appearance of the plants, from a healthy green to a yellow caſt. On the firſt appearance of this change, the uſe of the roller ſhould be had recourſe to, in order that the ſuperficial parts of the ſoil, which are probably become too looſe and porous, may be effectually preſſed, and thereby rendered too cloſe and compact to admit the worm to prey upon the tender roots of the young plants. That this effect may be produced in the moſt effectual manner, the roller ſhould be of ſuch a ſize, or ſo loaded, as to afford a preſſure equal to the draught of three or four horſes, which ſhould be yoked double, in order to increaſe the effect by their treading. It has been ſuggeſted, that, if by this method the injury can be counteracted until ſuch time as rain falls, there need not be any apprehenſion of the crop, as the plants will ſoon puſh forward in ſuch a manner as to become too ſtrong to be in danger from this inſect *. It is probable too, that top-dreſſings, ſuch as have been recommended for wheat, ſown over the crop immediately before the uſe of the roller, might be of utility in leſſening the ravages of this deſtructive worm. And it is found to be of the utmoſt conſequence to the ſucceſs of barley crops, that the weather prove moiſt about the period in which the plants ſhoot out into the ear; as where the contrary is the caſe, the crops are liable to ſuſtain much injury, from the want of that ſupply of food which is neceſſary for the perfect formation of the grain.

The produce of this kind of grain, like that of moſt others, varies conſiderably according to the ſtate of the ſoil, climate, and the cultivation that is employed; but the average over the whole kingdom is probably from about twenty-ſeven to thirty buſhels the acre. In the county of Middleſex, according to the Report of that diſtrict, the average produce is about four quarters of grain and two loads of ſtraw to the acre; and in Yorkſhire, on the turnip lands the produce is nearly the ſame; but in many other diſtricts it does not average more than three and a half. It is ſtated that, in Middleſex, the ſtraw generally fetches about one guinea a load when delivered in, which, together with the chaff and thin grain, is equal to one ſhilling and ſix pence the buſhel on the corn; and that as the corn averages three ſhillings, they produce together four ſhillings and ſix pence the buſhel, or ſeven pounds four ſhillings the acre.

* Synopſis of Huſbandry, p. 91.

In ſoils where barley crops become too rank and luxuriant, as may be the caſe in very open ſpring weather, on ſuch lands as are in a high ſtate of fertility, it may often be neceſſary to reſtrict the over-vigorous growth of the crops, by either feeding them down with ſheep, or cutting them with a ſcythe as a green food for animals; the latter method is ſaid to be preferable, as by it the rank tops are only removed, while in the former the whole is indiſcriminately conſumed, and particularly the ſtems of the plants at the joints about the ſurface of the ground, where they are ſweet and nutritious from the quantity of ſaccharine matter that is depoſited in them, by which much injury may be done to the future proſperity of the crops *. It is probable, however, that, independent of this circumſtance, barley crops can in but few inſtances, from their tender nature, and the expedition with which they ſhoot into ear, be fed down by ſheep without injury; as by the mutilation of the new-formed ears, and their being much retarded in their progreſs, the maturation of the grain may be too long delayed to be effected in a perfect manner. The practice, when neceſſary, can therefore only be had recourſe to with propriety at an early period.

This ſort of grain is ſhewn to be ripe by the diſappearance of the reddiſh caſt on the ear, or what by farmers is termed red *roan*, by the ears beginning to droop and bend themſelves round againſt the ſtems, and by the ſtalks becoming brittle and of a yellowiſh colour.

Barley ſhould conſtantly remain out in the field until it be perfectly dry and free from moiſture, otherwiſe it is liable to heat in the ſtack, and the ſample be thereby greatly injured both for the purpoſes of ſeed and malting.

It is found by experience that the Fulham barley, which has been once ſown on ſtiff loamy ſoils, is the moſt ſuitable for the purpoſes of malting, as the ſkin is thinner, and the quantity of meal conſiderably larger. From its quicker growth it is of courſe leſs expoſed in the field to the effects of moiſture, which is known to be highly injurious to this grain, and on which the good qualities juſt mentioned may in a great meaſure depend. It is the fine white clear thin-ſkinned barleys that bring the higheſt prices at the markets, whether they be ſold for the purpoſes of malting, or thoſe of ſeed.

Oats.—The cultivation of this ſort of grain has of late years been conſiderably increaſed, probably on account of the greater demand for them in conſequence of the great increaſe in the number of pleaſure horſes that have been kept.

It is a ſpecies of grain of which there are many varieties in cultivation; as

* Engliſh Encyclopædia, Art. Huſbandry.

the *white*, the *black*, the *red*, the *blue*, and the *naked* oat. There are likewiſe other varieties of this corn which are diſtinguiſhed by the names of the countries from which they have been introduced; as the *Poland*, the *Tartarian* or *Siberian*, and the *Frieſland* oat.

The *white* oat is a valuable kind, and where the ſoil is dry, rich, and in a good ſtate of cultivation, may be grown to great advantage, as it moſtly brings the beſt price at the market, and yields the moſt abundantly in threſhing out. It is cultivated the moſt extenſively where the uſe of oat bread is general, as it affords the whiteſt meal.

The *black* oat may be grown where the land is inferior in quality: it is nearly equal in value, from its being found ſo highly nutritious as a food for cattle and horſes.

The *red* or *brown* oat is likewiſe proper for the ſtronger ſorts of land; it is a very hardy kind, and affords a great increaſe. The grain is full and heavy, on which account it is probably to be preferred for the purpoſe of feeding animals to the above ſorts.

The *blue* oat is only cultivated in particular diſtricts. It is ſuggeſted in Miller's Dictionary as the ſort known to farmers under the title of *Scotch Greys*.

The *naked* oat is a kind that is but little cultivated, except in particular places. It has however the property of threſhing clean out of the huſk. This ſort has not, according to Ray, a hard huſk as in the common oat, but ſeveral thin chaffy coats. The grain is alſo ſmaller, but fuller in the body, and inclining to a tawny colour. It may be cultivated on the poorer ſorts of land.

The *Poland* oat has a ſhort full-bodied grain; but it has yet been little introduced into cultivation, probably on account of the thickneſs of its ſkin or rind. The ſtraw is ſhort, the grain ſet ſingle, and without awns.

The *Frieſland* oat has a thin-ſkinned grain, and a large proportion of ſtraw. The corns are for the moſt part double, the larger of which is in ſome caſes awned, the awn being ſituated high. It is moſt ſuitable for the better ſorts of land. It is known in ſome diſtricts by the title of the *Dutch* oat.

In the *Siberian* or *Tartarian* oat the grains are thin and ſmall, the largeſt of which are awned, but the ſmall ones without awns. The ſtraw is tall and reedy, on which account it is improper for the purpoſe of fodder for cattle. It may however be grown on the poorer ſorts of ſoil.

This ſort of grain is hardy, and may be cultivated upon almoſt any kind of ſoil; but, as in others, it is the moſt productive on ſuch as are ſtrong, rich, and adhetive, and which have been newly broken up from the ſtate of graſs. It is

ſuggeſted, that though this ſort of grain generally ſells lower than barley, yet, from its being a more certain crop, the ſuperior utility of the ſtraw for the food of cattle, and the increaſe in the quantity of produce, it is equal to barley for medium loams. And that for ſtronger ſorts of lands, and thoſe of the fen kind, it is greatly ſuperior to it, though apt to leave the land in a more foul and compact condition *. On the cold, tenacious, fenny, and wet deſcriptions of ſoils, the oat may indeed in many caſes be ſown with more advantage than any other kinds of crop, and likewiſe where lands cannot be put in a proper condition for barley crops.

Oats ſucceed well after almoſt every ſort of green and root crops, but ſhould not be cultivated after wheat, rye, or barley, where it can poſſibly be avoided, as the ſoil by ſuch cropping would be too greatly exhauſted. It has been obſerved, that, in diſtricts where improved methods of huſbandry are adopted, oats are generally grown upon ſuch lands as have been newly broken up from the ſtate of graſs, and that the practice is ſhewn to be perfectly correct, by the abundance of the produce in ſuch caſes. The cuſtom of cultivating oat crops in ſucceſſion for ſeveral years is equally abſurd and improper, and ſhould be generally exploded †.

In regard to the preparation for this ſort of crop, it is recommended by an intelligent cultivator, that when it is intended to be grown after cole, tares, early peas, or ſuch other crops as do not come off the ground later than the beginning of June, on ſoils that are too wet to admit of being ploughed in the winter ſeaſon to make a clean baſtard fallow, laying the land up into ridges proper for being ſown in the early ſpring. Or when after ſuch clean crops as come off too late to admit of baſtard fallowing, to plough only once, which ſhould be as early as the buſineſs of the farm will admit, into ridges proper for putting the ſeed in ‡.

It is remarked by Mr. Donaldſon, in his account of the preſent ſtate of huſbandry in this country, that whatever may have been the nature of the crop that preceded this, it is but in very few caſes that more than one clean furrow is afforded. In ſome diſtricts it is, he aſſerts, the common practice to plough the lands over that are intended for oats, in the autumn, in a particular manner, ſo as to expoſe as large an extent of ſurface to the influence of the atmoſphere as poſſible. This in ſome places is termed by farmers *rib-furrowing*, and in others *ſlob-furrowing*; it is performed by turning over the furrows at the diſtance of from twelve to

* Corrected Report of Middleſex.
† Modern Agriculture, vol. II.
‡ Ibid.

eighteen inches from each other on the unbroken land. In this way one half of the ſuperficial part of the land remains unmoved, and the furrows being thrown on it, much ſurface is expoſed, and the ſoil greatly improved, at the ſame time that the root weeds are deſtroyed. If this proceſs be accompliſhed in the moſt perfect manner, and in the autumnal ſeaſon, the ſoil is conſiderably ameliorated and improved by the froſts during the winter, and by being well broken down by the harrow in the ſpring, having a complete ploughing immediately before the ſeed is put in, the ſoil becomes in an excellent condition for this ſort of crop, even where the land is of the ſtiff and heavy kind. There can indeed be little doubt but that, by the land's undergoing a more full and complete preparation than is uſual for this crop, the quantity of produce may be greatly increaſed, as the fibrous roots of the plants are more enabled to extend themſelves in the looſe earth, and thereby to afford a more perfect ſupport to the plants. In ſome caſes, as where the land has been much reduced and exhauſted by the previous crops, or in breaking up thin poor ſoils where the proportion of turfy material is inconſiderable, and when the prices of other ſorts of grain are low, it may be advantageous to have recourſe to the uſe of manure, as by ſuch means it is probable that a third more produce at leaſt might be grown.

Time of ſowing.—In this buſineſs it is neceſſary to keep in mind that the earlier the ſeed is put into the ground, the ſooner in general the crop will be ready to cut. In the more ſouthern parts of the kingdom, it is often the caſe to put this ſort of ſeed into the earth towards the latter end of February, when the ſeaſon is dry and fine; but March is in general the oat ſeed ſeaſon. On ſuch ſoils as are naturally dry and parching, it is however by much the beſt practice to ſow early, in order that the crop may be well eſtabliſhed before the hot weather commences. And beſides, there may be a greater chance of the grain eſcaping the ravages of the worm that often attacks ſuch crops; and when this inſect is preſent, its ravages may be more eaſily prevented. As this ſort of crop is liable to be injured by very ſevere winters, it can ſeldom be ſafe to put it in in the autumn, eſpecially in the northern parts of the iſland; but in the ſouthern diſtricts it may be done with propriety in particular caſes, as where the land is of a very dry and friable nature, large crops having been aſſerted to have been grown in this way in combination with tares in ſome inſtances *.

Seed.—The proportion of ſeed that may be required muſt differ according to the difference of the circumſtances that have been already ſtated; but on ſoils

* Corrected Report of Middleſex, p. 187.

of a middling quality, four buſhels may be ſufficient for the more early ſowings, and five for the later ones, where they are put into the ground in the broadcaſt method, which ſhould conſtantly be the caſe where the firſt modes of preparation are adopted. In ſome of the ſouthern diſtricts the *Poland* oat is ſown at the rate of about four buſhels the acre for the firſt ſowings; and it has been found in practice that the earlieſt ſown crops conſtantly afforded the moſt perfect ſample, and in general the moſt abundant produce. With the oats, clover may be ſown when neceſſary, the ſeeds being covered by harrowing ſuitably to the condition of the land, and where the ſoil is very light or mellow, a roller ſhould be paſſed over it as ſoon after as poſſible, in order to preſs the mold to the ſeeds; but in other circumſtances it may be more adviſable to defer the rolling until the ſeaſon is dry, and the crop ſomewhat advanced in its growth. The practice of ſowing oats under furrow, though it has been attempted on the lighter and more dry ſorts of land, is not by any means to be adviſed, as in ſuch a method the ſeed is apt to be depoſited to too great a depth, and to be in danger of either being in ſome meaſure deſtroyed, or of coming up in an irregular manner. The uſe of the drill has not been ſo much practiſed with this ſort of crop as to aſcertain the utility of it; nor has that of dibbling been tried with that ſort of attention that is neceſſary to determine the propriety of it.

As this kind of grain is ſuppoſed to be more liable than moſt others to degenerate, by being too long continued on the ſame land, it has been the practice of ſome diſtricts to change it for ſuch as has been imported from other countries *. It is probable, however, that by collecting and ſowing the beſt and moſt perfect of our own produce, this expenſive practice may be rendered unneceſſary. By ſimilar attention moſt of the different ſorts of oats are alſo capable of being greatly improved both in the quality and appearance of the grain.

When this ſort of grain is cultivated on ſuch leys as are newly broken up, there may frequently be danger, eſpecially where the land has been long in the ſtate of graſs, both from the deſtructive attacks of inſects, and the ſoil becoming too light, open, and porous, from the decay of the graſſy material, for the ſupport of the plants. The firſt may probably in ſome meaſure be obviated, by eating ſuch lands very cloſely with ſheep previous to their being broken up, as by ſuch a method the ova of ſuch inſects may be much deſtroyed, and their propagation prevented. And the treading the crops by ſheep, as well as the

* Corrected Report of the North Riding of Yorkſhire.

roller, may likewiſe be beneficial in both reſpects. Horſes have alſo been turned in for the ſame purpoſe by ſome cultivators *. For the above reaſons, it has been ſuggeſted as improper to put oat crops in on newly broken up land, or even in the ſecond year's cultivation of them, or what in ſome diſtricts it termed a *lea-breech* †. Peas and beans, according to the nature of the ſoil, are generally conſidered as the moſt proper ſorts of crops in theſe caſes.

It is moſtly conſidered by writers on agriculture as a better and more correct practice to ſow graſs ſeeds with this crop than barley, as the tillage requiſite for the latter may diſpoſe it to become rank and be lodged, by which the graſs will be drawn up weak through it, and in that way be greatly injured; as well as the barley, by the humidity thus produced, require a longer time in the field, and in that way be expoſed to more danger in caſe of a wet ſeaſon ſucceeding, while with oats there is little riſk in theſe reſpects, as the ſtraw is much ſtiffer and more firm. Where oat crops are thin upon the ground, they grow ſtrong, and are conſequently better capable of ſupporting themſelves without falling on the ground.

After-culture.—The only culture that is neceſſary for this ſort of crop while growing, is that of keeping it as clean and free from weeds as poſſible, by means of hand-weeding, and the uſe of the forceps. It is alſo a practice in ſome places to paſs a light roller over the crop after it is advanced a few inches in height, when the ground has been ſlightly moiſtened by rain; by which the cloddineſs of the ſurface is reduced, and the plants in ſome meaſure earthed up, and the progreſs of the crop not only much promoted, but, where thin, the plants rendered more thick upon the land by the tillering that is thus produced.

Oat crops are ready for the ſcythe, or ſickle, when the ſtraw exhibits a yellowiſh caſt, the grain becomes hard, and the chaff opens in ſuch a manner as to render it in ſome degree naked. This ſort of crop does not require to be ſo dry when put into the ſtack as thoſe of either wheat or barley.

It is ſometimes a practice in this ſort of crop, as well as that of wheat, when there is danger of its being too rank or luxuriant in its growth, to feed it down with ſheep in the ſpring months. This is not, however, a method that is to be adopted, except in particular circumſtances, as where there is great difficulty in procuring ſheep feed at ſuch periods, or where the worm is committing its ravages upon the plants; as this ſort of grain is not in general apt to be injured either by the luxuriancy of its growth, or by being lodged.

* Banniſter's Synopſis of Huſbandry, p. 101. † Ibid. p. 102.

ADDITIONS AND CORRECTIONS

TO THE FIRST VOLUME.

To be read after Line 8, *Page* 5.—It has been ſuggeſted by an able agriculturor, that the breaſt of a plough ſhould be long and narrow, making an acute angle with the beam; the length of the breaſt tends to preſerve the *flag* from breaking, the ſurface for its ſupport being large. This is a very important conſideration in ploughing old leys for wheat, peaſe, &c., as a number of weeds are thus ſmothered which would otherwiſe inſinuate themſelves through the interſtices of broken ground. The reſiſtance of the earth againſt the breaſt, is alſo obviouſly diminiſhed in proportion to the acute angularity of the breaſt againſt the beam.

To be read after Line 10, *Page* 17.—On ſome very ſtiff clayey ſoils the ordinary cuneiform coulters have been found incapable of penetrating to a ſufficient depth without the aſſiſtance of extraordinary weight and preſſure. This great inconvenience has been in ſome meaſure overcome by adding to the extremities of the coulters a blade of iron to precede them, curved like an inverted ſcythe, or turned up, as it were, like the toe of a ſkate, thus: *a b* is the old-faſhioned coulter (the groove which conducts the ſeed being left blank), and *b c* is the curved knife now added to facilitate its inſertion; *d e* is intended to repreſent the level of the land.

This conſtruction of the coulters ſeems to poſſeſs the double advantage of facilitating their inſertion into the ground, and of affording ſome reſiſtance to any occaſional obliquity of direction to which the machine may be urged.

Implements uſed in the Cultivation of Hops.

To be read after Line 10, *Page* 28.—In preparing grounds for the reception of hop-vines, and in keeping them clean and free from weeds during their growth, ſeveral different implements are employed. The ſpade and the common hand-hoe are, however, in ſome places the chief tools that are made uſe of, though they obviouſly require much time, and conſequently increaſe the expenſe o the cultivator.

Hop-Shim.—This implement is conſtructed with a frame, ſomewhat in the manner of the common wheelbarrow, and has feet or teeth which cut up and drag out ſuch weeds as may be preſent at the ſame time, that they pulverize and prepare the

ground. Mr. Boys in his valuable Report of the Agriculture of the County of Kent, alſo obſerves that this implement may be advantageouſly employed for clearing ſummer fallows from weeds. When well made it coſts about two guineas.

Nidget.—This tool is formed of a triangular ſhape, and of different ſizes, according to the diſtances of the alleys in which it is to be made uſe of, with croſs bars or beams, in which are fixed a number of hoes in proportion to the breadth of the intervals between the rows of hops, ſo that its hinder part, which is the wideſt, may paſs without doing any miſchief to the binds on each ſide. The hindermoſt beam has fixed to it a pair of handles, by which the machine is directed in its operation.

The implement is drawn by one horſe, managed by a boy; and two acres may in this way be cleanſed in a day. Care ſhould however be taken, when uſing it, that in finiſhing, the alleys be all croſſed in the ſame direction, in order that every part of the ſurface, except the ſpaces which the hills occupy, may be cut over. The hills are to be afterwards rendered clean by means of hand-hoeing. It will be neceſſary to continue the uſe of this inſtrument as occaſion may require, until the branches of the hops are put forth in ſuch a manner as to prevent the horſe from going along the alleys. By this means hop-grounds may be kept clean and in order at a much leſs expenſe than by hand-hoeing, or even digging them in the ſummer.

The principal circumſtance to be attended to in the management of the nidget, is that of guarding againſt its damaging the binds by coming too near the poles.

Hop-Harrow.—By ſome hop-planters this tool is uſed after the nidget, for rendering the ground ſtill finer; it is conſtructed nearly in the form of the nidget, but with a ſmall wheel in the front, in order to go round at the ends of the plantation more readily. A pair of handles are fixed on behind, by which it is guided in the alleys, and kept from bruiſing the binds, by the perſon who holds them. Implements of this kind, when properly made, coſt from thirty to forty ſhillings.

Mr. Middleton, in his Report of the County of Middleſex, alſo ſpeaks of an inſtrument, in uſe by Mr. Maynard, for cleaning hop-grounds, which reſembles the ſnow-plough: in ſhape it is an equilateral triangle, the ſides of which are four feet long, and the front ones ſhod with old ſcythes; the whole being ſtrongly framed in order that it may be loaded when employed. He obſerves that "by drawing it once in a place, in the intervals between the rows, it renders them perfectly clean, and as ſmooth as the well-rolled walk of a pleaſure-ground, and earths up the rows by the ſame operation, which, about ten days afterwards, are eaſily made into hills with ſpades."

Peeler.—The peeler is made uſe of for forming holes for the hop-poles; it is a ſort

of iron crow, with a wooden handle acroſs at the top, and made thick and tapering, in order to remove the earth ſufficiently for the inſertion of the ends of the poles.

Hop-Dog.—This is a kind of lever, made of a long piece of good wood, with a fixed fulcrum, to the lower end of which is faſtened a ſtrong piece of iron with teeth, which graſp the lower end of the hop-pole firmly, and by the action of the lever wrenches up the pole.

To be read after Line 10, *under the Head* Chaff-Cutters, *Page* 32.—A wheel with two knives fixed on its radii will, however, it is believed, cut more ſtraw in a given time, and with a given force, than a wheel with three knives; as where there are three knives one of them is always upon the ſtraw; the reſiſtance is, of courſe, ſo great and conſtant, as materially to diminiſh both velocity and momentum, and conſequently power. Mr. Burrel, of Thetford, in Norfolk, we believe, has attached to the ſide of theſe machines a crank, which, by means of a ſpindle terminating in a cog-wheel, much aſſiſts the primary force. Two boys, or women, are capable of turning this wheel for many hours together. It is probable that the application of a multiplying wheel to theſe machines would much facilitate the labour of them.

To be read after Line 15, *Page* 52.---It is alſo of importance that ſtables ſhould be better lighted than they uſually are; the blindneſs ſo frequent among horſes has been attributed with conſiderable plauſibility to an exceſſive ſtimulus of light on their coming out of a dark ſtable, where the irritability of the organs of ſight has been for hours accumulating, into the full glare of day. Farm ſtables, during the ſummer ſeaſon, are very generally expoſed to the open air; the door or wicket is ſeldom ſhut but at night: In conſequence of this expoſure, flies, which are attracted by the horſe-dung, &c. have free acceſs. It will generally be obſerved, however, that, in ſuch expoſed ſtables, cobwebs alſo are very numerous: it is unwiſe to diſturb them; the ſpider ſhould be cheriſhed, as he ſaves the horſe from the irritation of many troubleſome enemies. The proviſion is natural, and ſhould be attended to.

To be read after Line 4, *Page* 67.—On the mode of applying fuel in the firſt inſtance, and ſteam in the ſecond, to culinary proceſſes, both on a large and ſmall ſcale, Count Rumford's Philoſophical Eſſays may be conſulted with much advantage.

To be read after Line 18, *Page* 75.—The price of brick-burning in Nor-

folk is at this time from a guinea to twenty-five ſhillings per thouſand, the brick-burner finding fuel. Perhaps it is as well for the proprietor to provide fuel for himſelf; as, when provided by the man who takes the job, there is great danger that the bricks will be inſufficiently burnt; which is a fraud that cannot be diſcovered till it is too late to apply a remedy.

To be read at the End of Section III, Page 97.—There is another mode of conſtructing cottages that may be had recourſe to with economy and advantage in particular ſituations and circumſtances; this is that of building in what is termed *Piſé*, or ſimply by compreſſing well-wrought earth in moulds or caſes contrived for the purpoſe. It is a method that has been long practiſed in the vicinity of Lyons, in France, with great benefit, and has been attempted in this country with equal ſucceſs. It is particularly recommended by the cheapneſs of the materials that are made uſe of; the facility with which they can be procured in almoſt every ſituation; and the vaſt ſaving in time, carriage, and labour, that attends it; and it is ſaid to afford buildings that are equally neat and durable.

The manner of preparing the materials, and performing the work, with repreſentations of the different implements that are neceſſary to be employed, have been deſcribed, with much accuracy and correctneſs, from the publication of M. Cointeraux, by Henry Holland, Eſq. and inſerted in an Appendix to the Firſt Volume of Communications to the Board of Agriculture, which may be conſulted on the ſubject.

To be read after Line 33, *Page* 103.—It has been ſuggeſted that, in making incloſures, ſomething more ſubſtantial ſhould be given to the poor cottager in exchange for his benefits, whether they be conſidered real or imaginary, which he derives from his common, than the hope of participating with the whole in the general advantage which may be produced. Various clauſes have been provided in different acts of incloſures in this intention. In ſome, much diſpute and inconvenience has been avoided by inſerting clauſes for increaſing the allotments of thoſe owners and proprietors whoſe property may be above the annual value of five pounds, and under ten, ſo as not to exceed the proportions allotted to any other proprietors whoſe property may amount to the annual value of ten pounds. The ſpirit of which ſeems to be: "First, that every proprietor whoſe property is above the annual value of five pounds, and under the annual value of ten, have an extra allotment; and Secondly, that the value in this extra allotment ſhall, as nearly as poſſible, be inverſely proportionate to the property to which it is attached; the commiſſioners conſequently taking care that in no inſtance the allot-

ment to the ſmaller property ſhall exceed in value the allotment to the larger." And in reſpect to proprietors whoſe property is under the annual value of five pounds, by allowing them double proportions on a certain part not to be incloſed; or by ſuffering them to have allotments in ſimilar proportions, according to their properties, to thoſe whoſe property was above five pounds.

With the view of benefiting the ſtill more poor tenants, or renters of cottages, it has been ſuggeſted that by the providing of a clauſe for the purpoſe of allotting a portion of land for the convenience of building a number of ſolid, convenient, and airy cottages, to be held in truſt for the pariſh, many advantages might have been gained*.

To be read after Line 6, *Page* 123.—The white-thorn ſhould, on no conſideration, be *leſs* than four years old when it is planted; if younger, it is unable to encounter the drought of the firſt ſummer. An intermixture of holly in white-thorn fences is at once ornamental and uſeful: the young plants ſhould be carefully weeded and moulded up every ſpring, for the firſt three or four years. They ſhould alſo be cut down the third or the fourth year, within four inches of the bank, in order that they may throw out lateral ſhoots, and thus become thick at the bottom. Too much care can ſcarcely be beſtowed in cheriſhing young fences, in preſerving them againſt the nibbling of ſtock, againſt the ſeverity of drought, and the double injury which weeds commit, by choking them with their own luxuriant growth, and by robbing them of their neceſſary nouriſhment.

To be read after Line 20, *Page* 145.—It has been lately well obſerved, in an able Eſſay on the Conſtruction, Hanging, and Faſtening of Gates, that, when ſuſpended by hinges, a gate is a lever of the ſecond kind, in which the weight is placed between the power and the fulcrum; as it is evident that the hand applied to the head of the gate is the *acting power*, the gate itſelf the weight to be raiſed or moved, and the hinges the fulcrum or centre of motion. "When the hooks or pivots upon which a gate is hung are preciſely perpendicular to each other, the gate will be at reſt wherever it may be placed, and the ſame power which is required to move a gate thus ſuſpended through any given arc of the circle, will be exactly ſufficient to bring it back to its former poſition;" a proof of which is ſeen in a common door to a room with plain hinges. "But the ſmalleſt variation of the hooks from their perpendicular line, will attach to a gate, ſo ſuſpended, one determinate line of reſt; and from any part of the circle which the gate may be made to deſcribe, it muſt have a conſtant tendency to fall to that line of reſt. The line of reſt for a gate will always

* Monthly Magazine, Vol. VII. p. 358.

be where it approaches neareſt to the ground; and from thence being moved half a circle to the right or left, it will there attain its greateſt elevation, and ſupport itſelf, or, with a very ſlight aſſiſtance, may be ſupported in equilibrio. When a gate is in its line of reſt, or in its oppoſite line of equilibrium, the two hooks by which it is ſuſpended, and the centre of the gate's gravitation, will be in the ſame vertical plane with each other; which may be eaſily underſtood by obſerving a common gate, whoſe hinges are put on in any manner, however awkward or perverſe. And when the hooks are in one perpendicular line, it can admit no doubt but that they muſt always be in the ſame vertical plane with the centre of the gate's gravitation, becauſe they will be ſo with any third given point whatſoever. Theſe principles are alſo applicable to a common ſwing gate, which has two or more pivots or hooks at the lower hinge, when the poſition of either one of the lower pivots is conſidered with reſpect to the upper hook*." In explanation of theſe principles, a figure is given which is ſuppoſed "the outline of a gate nine feet two inches long, from the fore part of its head to its upper point of ſuſpenſion, repreſented in the line of reſt, as well as in the oppoſite line of equilibrium; ſhowing the velocity with which the gate is made to fall, from an elevation of ſix inches gained at the head in attaining its line of equilibrium, eſtimated from the line of reſt by means of the poſition of the two hooks, and the proportionate extra length of the lower thimble†." And it is contended that "the line of faſtening ſhould be 22° 30′, or 1-ſixteenth part of a circle, ſhort of or within the line of reſt, and conſequently the correſponding line of equilibrium will alſo be 22° 30′ ſhort of the greateſt extent of the gate's opening‡." But in order "to prevent the gate being left unſhut, it is adviſed that a ſhort poſt ſhould be placed at about half the diſtance between the road to be paſſed and the fence adjoining the hanging poſt, that is 22° 30′ within the line of equilibrium; ſo that the gate ſhould not open from its line of faſtening more than about 135°, which will anſwer every purpoſe; and the hinges muſt be ſo adjuſted that the gate ſhall be perfectly upright at its line of faſtening§." It is ſtated that a gate, ſuſpended in this manner, cannot be left open, (excepting in high winds) but will ſhut of itſelf, though not with an uniformly accelerated motion, as might be ſuppoſed; its velocity being rather increaſed as it paſſes the middle part of its ſemicircular courſe, and retarded again as it approaches its line of reſt, coinciding with the proportionate riſe of the head, allowing only for ſuch acceleration as muſt be acquired while the gate, in falling with a continued motion, recedes more and more from the line of equilibrium. As the *verſed ſine* of the angle formed by the gate with its line of reſt, is to the length of the gate 110 inches, which is the made radius, ſo will be the cor-

* Parker's Eſſay on Gates. † Ibid. ‡ Ibid. § Ibid.

responding rise of the head of the gate to $3\frac{7}{16}$th inches, or half the whole rise of the gate's head, at any given angle within the quadrant: and the rise in the head afterwards will be, as the *co-sine* of any given angle formed by the gate with its line of equilibrium in describing the complement of that angle, is to the length of the gate, or radius, so will be the corresponding rise of the head of the gate to the remaining $3\frac{7}{16}$ inches, which *co-sine* of the angle formed by the gate, with the line of equilibrium, is equal to the sine of the complementary angle, or angle of the gate's progress, from a radius at right angles to, or equi-distant from, the lines of rest and equilibrium, in performing its supplementary course. Thus it appears, that though the rise of the gate at the head in the first 90°, or half of its semi-circular course, be $3\frac{7}{16}$ inches, yet in the first and last 22° 30′ of its course, it will rise only 1-fourth of an inch, or exactly $\frac{6}{24}$ths and $\frac{69}{1116}$ths of a 24th in each respectively; and rejecting the greater fractions, the rise of the gate's head, and corresponding velocity of the gate's fall in equal eighth parts of its semicircular course, is nearly in proportion to the numbers 6, 16, 26, 32, and then inversely 32, 26, 16 & 6.*

And in further illustration of the above principles, a "representation is given of the horizontal section of two hooks for a right-handed gate, opening one way, brought into one plane of observation; the upper hook, the lower hook, the line of fastening, the line of rest, and the line of equilibrium. The diameter of the hooks $\frac{3}{16}$ths of an inch, which is the proper size for a common gate. The horizontal distance of the lines falling from the two hooks being $\frac{3}{4}$ or $\frac{15}{16}$ inch, is the measure adapted to hinges which are forty inches asunder. In adjusting the hinges, it is necessary that the upper thimble should incline $\frac{1}{4}$ inch from its centre towards the hanging post, and that the lower thimble should be screwed into the heel of the gate $\frac{1}{4}$ inch out of the straight line, inclining in the opposite direction, that is, from instead of towards the hanging post, both thimbles together making a variation of the $\frac{6}{16}$ inch; and to correspond with this variation, the upper hook should measure, from the centre of the pin to the shouldering, about half the thickness of the heel of the gate, as the $\frac{1}{6}$ inch inclination of the upper thimble will allow sufficiently for the gate hanging clear of the post. The lower hook must be $\frac{6}{16}$ inch longer than the upper hook, and must be driven into the gate-post $1\frac{1}{8}$ inch out of the perpendicular line of the perforated parts of the gate-post, in which the hooks are to be received, as the lower thimble must also exceed the upper thimble in length $1\frac{3}{4}$ inch, supposing the gate to be a right-angled parallelogram, or at least the rail and heel to be at right angles with each other; else the lower thimbles must be extended by a washer to make up the deficiency, which, however, will not at all

* Parker's Essay on Gates.

interfere with the velocity of the gate's fall, because the hooks are the centre of motion upon which all adjuſtment, as to the gate's fall, depends, the places of the thimbles influencing only the upright poſition of the gate when faſtened. The numbers of $\frac{6}{12}$ rather ſurpaſs the preciſe meaſure of their reſpective ſides of the triangle, but are nearer to the truth in calculation than any workman could attain in applying theſe directions; for in neither caſe do they exceed their true meaſure ſo much as $\frac{1}{24}$ of an inch, and therefore in the one the clear ſum of $\frac{1}{4}$ inch is aſſumed for general purpoſes; and ſhould the hinges be leſs than 40 inches aſunder, $\frac{1}{4}$ inch will be rather too much; or were they to be more than 40 inches diſtant from each other, $\frac{1}{4}$ inch, on the contrary, would be rather too little for the juſt proportion. It is certain that a ſmall ſpace muſt be loſt in hanging a gate, though the hooks and thimbles be made with great exactneſs; for the weight of the gate will draw the upper thimble to bear upon the hind part of the upper hook, and will preſs the lower thimble againſt the fore part of the lower hook; this muſt be trifling when the hinges are well fitted, and no allowance is made for it, becauſe the lower thimble gains as much upon the upper one by their being placed $\frac{1}{4}$ inch, that is $\frac{1}{4}$ inch each, out of the plane of the gate's extenſion, as appears by the difference of the ſides of the triangle, numbered $\frac{11}{12}$, and $\frac{5}{12}$ equal $\frac{1}{12}$ inch by the meaſure $\frac{5}{12}$, which is aſſumed, but really about $\frac{1}{24}$ inch more, as ſtated above, or on the whole equal to $\frac{1}{3}$ inch, which is a good general equivalent for the loſs in hanging a gate, and will uſually be ſufficient to preſerve the upright poſition of the gate when faſtened, without having recourſe to a waſher at the lower thimble*." It is remarked that the "velocity as above given to the gate's fall will be amply ſufficient without any care of oiling the hinges; but the effect of wind cannot be counteracted in gates by any good conſtruction of the hinges; for were a velocity given to a gate's fall equal to the reſiſtance of ſo powerful an agent, the gate would ſoon want repair, from the conſtant violence of its ſhutting, and be ſo much the heavier in the hands of a horſeman: beſides, when a ſtrong wind blew in the ſame direction as that of the gate's fall, no man on horſeback would be able to withſtand its force; and well conſtructed gates are moſt liable to be acted upon by wind, from their wide extent of ſurface. But if paſſengers are ſo careleſs as to leave gates open under ſuch circumſtances, there will be one ſatisfaction remaining; that is, as ſoon as the wind ceaſes, the hinges muſt reſume their property, and the gates faſten of themſelves†.'

Various directions are given, by which the new poſition of the hooks may be found when the hinges of gates are more or leſs than forty inches aſunder. In proof of the accuracy of which, "ſuppoſe a gate to be 110 inches long, and that it is in-

* Parker's Eſſay. † Ibid.

tended to rise at the head $6\frac{7}{8}$ inches in its semicircular course, from the line of rest to the line of equilibrium; then, as the length of the gate is to the distance between the two hinges, so will be $6\frac{7}{8}$ inches to double the horizontal distance of two perpendicular lines, one falling from each of the hooks." Or "take any other distance of the hinges from each other, and the required extra length of the lower thimble may be found by placing the numbers 110 and $6\frac{7}{8}$ as the first and second terms of a rule of three proportion, and the new distance of the hinges must be the third term; the answer, divided by two, will be the sought-for horizontal distance of the two perpendicular lines falling from the hooks (adding the loss in hanging the gate); the answer for the one is the measure for the other*." It is supposed that "these general rules will find a tolerably accurate measure in all cases; for where a gate or wicket is short and light, the friction of the hinges will be less in two respects, both by the diminished pressure on the hooks from the gate's lightness, and the reduced diameter of the pivots, which will supply what is wanting in the weight or momentum of the gate. On the other hand, when the gate is long and heavy, its increased weight or momentum, and its length as a lever, will be opposed to the additional friction of the hinges." And "in cases where old hinges are badly made, with large hooks or deep thimbles, that difficulty is to be met by taking the proportion for the distance of the two hinges from each other at five or ten inches more than it really may be, with reference to the given table, or by adding something to the usual horizontal distance of the lines falling from the hooks. But when the thimbles are of a long cylindrical form they are extremely apt to bind upon the hooks, and will sometimes put a dead stop to the gate's motion. With such thimbles the attempt of adding to the velocity of a gate's fall may only increase the binding or friction; and the remedy for this defect, therefore, is to make the hooks much smaller than the thimbles: in new thimbles, no form but that of annular, or ring-like, should be admitted." By "the lower thimble being furnished with a screw of equal diameter throughout its length, its extra length may be regulated to so great a nicety as half a turn of the screw, and may either be let into the heel beyond the shouldering, or lengthened out by a washer as circumstances require, in adapting it either for hinges, which are less than forty inches asunder, or the contrary, without the help of a blacksmith or any fresh forging, which is always troublesome and expensive. And if a gate sinks at the head, without any fault in the hanging-post or hooks, the lower thimble may be lengthened out to bring the gate upright, and the hooks remain unaltered†."

* Parker's Essay on Gates. † Ibid.

Gate-Poſts.—Theſe ſhould "be of a ſufficient length and ſtrength; and being fixed about eight feet nine inches aſunder will be adapted for a gate nine feet long, or nine feet two inches including the thimbles: the thimbles being attached to the gate in the manner above directed, let the gate be ſupported where it is to hang and faſten, and then drive in the upper hook at a convenient diſtance from the edge of the hanging-poſt, ſo that the upper hinge ſhall not be in the way of any carriage paſſing the road, but at the ſame time ſo near to the edge of the poſt as to loſe no more room for the road than is unavoidable, by the head and heel of the gate extending a little upon the two poſts. It is not neceſſary to the gate that it ſhould lap againſt the hanging-poſt at all; but ſince the head ought to meet the falling-poſt, at leaſt with half its own ſubſtance, or from that to two inches, the hanging-poſt ſhould be nearly as much covered by the heel for the ſake of uniformity. When the upper hinge is fitted, the gate ought to be ſupported upright, for aſcertaining the place of the lower hook; and if the thimbles are properly put on, the poſition of the lower hook cannot be miſtaken. Both hinges being fitted, it remains to be found whether the hooks are in their exact places; for this purpoſe take two plumbed lines, with fine threads and heavy even-ſided plumbs; if the hooks are well finiſhed, the obſervation reſpecting their centres may be taken by faſtening the plumbed lines round the hooks, and letting them fall from the outſides of ſimilar parts of the hooks; forty inches being the given diſtance of the hinges, the horizontal diſtance of the two lines falling from the hooks ſhould be 1¼ inch, and in a line which forms an angle of 22° 30′, with the gate's line of faſtening: take, therefore, a common two-feet rule, and, having opened the legs to the angle of 22° 30′, place one ſide of it againſt the plumbed lines, which ought to anſwer to the meaſure of 1¼ inch, while the other leg of the rule ſhould be parallel to the gate's line of faſtening; a ſlight blow or two with a hammer on one or both of the hooks, in the direction neceſſary, will complete the adjuſtment; and the gate will be found to ſhut of itſelf from any line within 135° from its faſtening, and without violence, whether opened to the ſmalleſt, the greateſt, or any intermediate angle preſcribed by the ſhort poſt, which ſhould be placed to meet the middle part of the gate at the angle of about 135° from the line of faſtening*." And "it might be prudent, before the ſhort poſt were put down, to aſcertain at what line the gate will ſtand open, or be poiſed by the friction of its hinges towards the line of equilibrium, which will diſcover how near the workmen may have adjuſted the line of faſtening to 22° 30′ ſhort of the natural line of reſt;

* Parker's Eſſay on Gates.

and if the gate is found to fall properly, the ſhort poſt may be put up accordingly, though the method deſcribed may not have been minutely purſued, taking care that the ſhort poſt be ſufficiently within the line of equilibrium, and that the gate ſet off from the ſhort poſt with a velocity equal to overcome any increaſed friction by ruſt on the hinges, for oil ſhould not be uſed at all, as its occaſional aid is not to be depended on *."

It is obſerved that "indifferent gate-poſts are liable to get out of their upright poſition; the conſtant weight of the gate muſt have a tendency to pull the hanging-poſt inwards; the fall of the gate may make the falling-poſt recede from the direction of the frequent blows it receives, and heavy carriage-wheels paſſing near the poſts, will occaſion them to open outwards; and the natural or artificial ſlopes of the ground adjoining gate-poſts often affect their upright poſition, and decline them from the higher ground," and many other cauſes produce ſimilar effects, to obviate which many contrivances have been recommended; ſuch as "mortiſing the pair of gate-poſts together by croſs pieces of timber under the road; but the moſt effectual preventive of the evil appears to be that of letting down the poſts very deep into the ground, which will ſuperſede the expenſe of croſs timbers; and in gaining a firm hold at their baſes, they will be the better ſecured both from natural and accidental diſplacement †." Gate-poſts for common gates ſhould be from eight to eight feet and a half in length.

Care is alſo "to be taken in hanging a gate, to chooſe the beſt ſide for it to open; in doing which there are two circumſtances to be conſidered; the principal one is, that there may be plenty of room for a ſervant on horſeback to hold the gate while a carriage paſſes, and the other is, to avoid its opening againſt any croſs road or path: Add to which ſome attention is due to the treſpaſs of cattle from a common road, or otherwiſe; and it is thought more ſecure for a gate to open againſt that ſide from which the treſpaſs may be moſt apprehended. In ſome caſes it is adviſable to furniſh a hanging-poſt with a pair of hooks on both ſides of it, ſo that the gate can be ſhifted as occaſion may make it convenient ‡."

A key-hole and cotter may be put in the lower hook "to ſecure the gate from being taken off the hinges for idle purpoſes; or a ſtud rivetted to one ſide of either of the hooks, with a little notch cut in the ſtrongeſt part of the adjoining thimble, is a ſimple and good contrivance, whereby a gate is prevented from being taken off the hinges when ſhut, but is eaſily taken off at ſome one part of its courſe when required, where the ſtud comes oppoſite to the notch, and admits the thimble to paſs over the ſtudded hook." And it is not uncommon to ſee one hook

* Parker's Eſſay on Gates. † Ibid. ‡ Ibid.

driven into the poſt with its point upwards in the common way, and the point of the other hook in the contrary direction, which is an effectual mode of keeping the gate on its hinges; but it has the inconvenience of not permitting the gate to be removed without drawing one of the hooks.

The ſame principles are applied in the hanging of gates on the contrary ſides, and likewiſe to thoſe of ſwing-gates; full explanations of which may be ſeen in the very uſeful Eſſay referred to, as well as the methods of ſawing timber for gates and gate-poſts.

The methods of hanging and faſtening, as well as the inconveniencies of ſwing-gates, are alſo explained with great ingenuity and practical accuracy; but they will be beſt underſtood by peruſing the Eſſay, as they cannot be fully comprehended without the plates.

Mr. Parker has likewiſe found, that caſt-iron may be applied with ſuperior advantage to the purpoſe of hanging and faſtening gates, the hooks being attached to the poſts by means of ſcrews, inſtead of being driven in as in the uſual mode. By this means it is ſuppoſed that a ſaving of at leaſt fifty per cent may be made. Complete ſets of which are furniſhed by Meſſrs. Deermans, Francis and Company, Eagle Foundry, Birmingham.

To be read after Line 4, *Page* 152.—In the above reſpect it appears that roads formed on the model of a gently-inclined plane have an obvious advantage; for the very ruts which the wheels make ſerve as channels to conduct the water down the deſcent; at the loweſt point of which a tranſverſe groove ſhould be kept open to convey it into the ditches on either ſide. So extremely gentle is the *neceſſary* deſcent, that grooves at the diſtance of one hundred and fifty yards will be found in moſt caſes ſufficient. The water has thus ſeventy-five yards to run, and the elevation need not be above eighteen inches, or two feet. It is commonly to be obſerved, that the convexity of a road is inverſely proportioned to its narrowneſs. Turnpike roads of the full ſtatute width, unleſs unuſually ſhadowed by trees, receive ſo much ſun and air, that they are kept tolerably dry without much convexity of their ſurface. Narrow roads and lanes are only to be kept dry by artificial means, and ſometimes the convexity is ſo extremely great, as to render the paſſing of two loaded carriages extremely dangerous. Perhaps the gentle convex ſhape is preferable for turnpikes, but the ſhape of the longitudinal-inclined plane has many advantages in narrow lanes, &c.

To be read after Line 6, *Page* 158.—The caſes where it would be neceſſary to carry off the water every ten or fifteen yards muſt be extremely rare; perhaps there are

few ſuch caſes. It has been obſerved, that "a carriage might almoſt as well be floating on a billow at ſea, as toſſing up and down on an inclined plane every ten or fifteen yards! When a road is conſtructed on the principle of the plane, there ſhould be no ſloping of the ſides; otherwiſe the water is impelled by two forces at right angles with each other, and conſequently tends in a diagonal line.

To be read at the End of Section V.——*Embankments.*—In many ſituations extenſive tracts of land may be gained by the judicious conſtruction of embankments. In improvements of this ſort, the proper forming of the *banks* conſtitutes the principal difficulty and expenſe of the undertakings. The particular circumſtances of the caſe muſt chiefly direct the operator in regard to the ſituation, ſize, and manner of conſtruction, as well as the nature of the materials which are to be employed. In general, however, the ſituation of ſuch banks ſhould be ſuch as that their baſes or foundations may not be unneceſſarily expoſed to the direct action of waves or currents. Where the quantity of water is in ſome meaſure limited, as in the caſe of land floods in particular inſtances, the greater the ſpace it has left to extend itſelf in, the leſs height and ſtrength will be requiſite in the bank, and the force of the current be leſſened in the ſame proportion. But where the courſes are liable to be filled up by depoſitions, it ſhould be recollected that the more the water is confined the ſtronger the current will be, and the leſs the danger of their filling up.

In regard to the line of an embankment it ſhould always be *even*, and as free from *irregularities* as poſſible, in order to occaſion the leaſt poſſible *reſiſtance* to the currents of whatever kinds.

In forming the bank, the height and ſtrength ſhould conſtantly be made in proportion to the depth and weight of water that it may have to reſiſt, always having the inner face made to incline towards it, for the purpoſe of ſupport in the way of a buttreſs. The out-face muſt be formed in a ſloping direction, ſo as to approach a degree of flatneſs, in order to obviate *reſiſtance*, and leſſen the *preſſure* or *weight* of the water. On this being properly executed its firmneſs and durability greatly depend. In difficult caſes, it is adviſed that the outer ſurface ſhould form an angle to a perpendicular line of from forty-five to ſixty degrees, according to the force to be oppoſed and the nature of the materials employed*.

In reſpect to the materials, where the foundation is good, firm, and ſolid, and the bank can be conſtructed at a ſuitable time, without much interruption from the water, the natural earth of the ground may anſwer perfectly for the body of the

* Marſhall on the Landed Property of England.

bank as well as the inner ſurface; and where the preſſure of ſtagnant or almoſt ſtill water is merely to be reſiſted, the outer ſlope may be formed of the ſame. But in caſes where the force of either waves or currents operate directly upon the banks, the outer ſlopes ſhould be well ſecured againſt it, with the beſt materials that can be conveniently provided, and the baſes or foundations be properly ſecured from being undermined; piles, timber, and maſonry being had recourſe to where the foundations are not ſufficiently firm and ſolid. It is of the utmoſt importance in theſe caſes to guard againſt accidents.

Beſides the conſtruction of the banks, attention is alſo neceſſary to the forming of the diſcharging channels on the outſides of the embankments. The poſition of the mouth, or out-fall, ſhould conſtantly be ſuch as that the current of the receiving waters may not warp or fill them up, but tend to clear them out, and keep them free. They ſhould likewiſe be ſituated as low as they can be conveniently permitted below the flood-gates of the banks, the better to induce currents, and thereby keep the flood-gates and the mouths of the channels the more free and open.

In caſes of open ſeas or other extended waters without any diſcharging channels, but where the waves extend to the foot of the banks, two flood-gates may ſometimes be neceſſary, one on the external ſide, to reſiſt the force of the waves, and prevent their *blowing up* the works on the inſide; the other on the inner ſide, to ſecure the paſſage more fully. Thus, when water is admitted by the outer flood-gate being lifted by the waves, its progreſs is effectually ſtopped by the inner valve being in a perfect ſtate. Where the valves are liable to be choked up, from being ſituated below the ſurface of ſand or other ſhifting banks through which the water forces its way, and are only capable of being kept clear by conſtant trouble and expenſe, the remedy, in difficult caſes of this nature, is that of defending the diſcharging flood-gates by *covered* channels carried out into the ſea through the line of beach, made ſufficiently ſtrong to reſiſt the force of the waves, This is however an expenſive method, and ſhould of courſe be avoided when poſſible*. In all caſes where external valves or gates are required, and liable to be filled up, great care muſt be taken to keep them open and free, either by piles, fences, or other contrivances, run out in ſuch a manner from the embankments as not to interrupt the diſcharging water, the earthy materials collected by it being occaſionally removed.

In theſe caſes, common *hinge flood-gates* may be the moſt proper, or ſuch as ſwing outward, and fall into a rabbetted frame. They ſhould be always made of ſeaſoned oak timber; being made double, by the different planks croſſing each other, in order to prevent their warping. They ſhould be ſo contrived as to fit pretty tight, with-

* Marſhall on the Landed Property of England.

out being liable to ſtick by ſwelling. This is effected by the edges being made to ſlant or bevel inwards. The frame ſhould likewiſe incline a little inward, but not ſo much as to retard the exit of the contained water. Where rivers or ſtreams paſs through embanked grounds, the ſides may frequently require to be raiſed ſufficiently to prevent their overflowing in times of floods. And where they are too low to be fully drained, it may be neceſſary to form embanked channels or cuts for receiving the water when thrown up by machinery. Theſe embanked channels may be converted to various uſes, ſuch as irrigation, &c. in different caſes *.

Embankments have been divided into three different kinds, as thoſe againſt the ſea, againſt rivers, and againſt lakes, each of which ſhould be formed according to the reſiſtances required. The firſt, however, in general require by far the ſtrongeſt and moſt expenſive works †.

In embanking againſt the encroachments of the ſea, it ſhould firſt "be conſidered what is the greateſt depth of water at the higheſt ſpring tides. About two feet higher than that ſhould be the ſummit of the bank. Some have recommended only one foot higher, but it is beſt to err on the ſafe ſide; for the conſequences attending an overflow, after the whole is completed, may, in one tide, do a great deal more damage than all the expenſe of the additional foot in height. If the embankment be made at firſt even three feet higher than the higheſt riſe of the tide, eſpecially at thoſe places expoſed to the waves or ſwell of the ſea, it will be ſo much the more ſecure; for new works of this kind always ſubſide or ſettle in ſome degree after they are erected. It is a very neceſſary precaution, particularly if the banks are large, to take the levels frequently for ſome time after they are completed, leſt they ſhould ſubſide too much, and thereby occaſion a miſchief which it was imagined had been ſufficiently guarded againſt. If the banks are but low, this precaution is not ſo neceſſary, for the ſettling will always be more or leſs according to their height, and in low banks will be but very little. It is hardly poſſible to give one general rule reſpecting the ſize and dimenſions of ſuch embankments. This muſt be regulated according to circumſtances and ſituation, for which a ſkilful engineer will always make the proper allowances. If the embankment to be made is to exclude the ſea from a low marſhy piece of ground, over which it flows only at ſpring-tides, the operation is eaſy, and may be effected at a ſmall expenſe. If it is intended to reclaim a piece of land that is covered every tide, either in ſome bay or creek, or on the ſides or windings of ſome large river

* Marſhall on the Landed Property of England.

† Beatſon in Communications to the Board of Agriculture, Vol. II.

in which the tide ebbs and flows, the work will be ſomewhat more difficult, in proportion to the depth of the water and the rapidity of the current. If it is propoſed to exclude the ſea from ſome expoſed ſituation, either at the mouth of a river, or in a bay or inlet uncovered every tide, the work will be the moſt difficult and moſt expenſive of all, in proportion to its expoſure to prevailing winds and to the depth of water to be reſiſted. Each of theſe ſituations require a different mode of management. Embanking againſt the ſea, if at any conſiderable diſtance within high-water-mark, is not only the moſt tedious, but the moſt difficult of all; for if the materials are not very good, and the work is not properly performed, the force of the water at every flowing of the tide will ſoon undo all that has been done, eſpecially if the ſoil is of a ſandy nature, as it often is in ſuch ſituations. If it is a ſtrong clay, as is ſometimes the caſe in marſhy places, there will be the leſs riſk of its being waſhed away. In ſandy ſituations it has by ſome been recommended to lay bundles of ſtraw or reeds well faſtened down, or any other impediment, to prevent the ſoil being carried away by the ebbing tide. Where a ſufficient quantity of good ſtrong turf cannot be had, then expedients may be tried; but where ſuch turf is to be got, as in moſt marſhy ſituations, and where the embankment required is not to exceed the height of four or five feet, it is beſt to finiſh the ſlope with good turf as expeditiouſly as poſſible as the embankment proceeds; that is, ſuppoſing a length of thirty, forty, or fifty feet, or yards, of it can be completed in a tide, it is better to finiſh that length to its intended height, than to trace out or begin a greater extent than can be finiſhed before the tide returns, by which a great deal of the ſoil might be carried away, and much of the work demoliſhed, which is not ſo likely to be the caſe when the ſlope is finiſhed. *Turf, containing the roots of* bent or ruſhes, is very good for this purpoſe. The firſt thing, however, to be done in an embankment of this ſort is, to ſtake out the intended line of it, marking the breadth at the baſe, alſo the width of the excavation, or trench, to be made in the inſide, from which moſt of the materials that compoſe the bank are to be taken; this trench alſo ſerves as a drain to keep dry the grounds within. At different parts of it ſhould be trunks, or ſluices, to ſhut of themſelves againſt any external water, and to open, when the tide ebbs, to let out any water from within. Its width muſt be proportioned to the quantity of materials required from it for the embankment—eight, ten, or fifteen feet wide, and three or four feet deep, leaving a *berme*, or ſpace between the edge of the trench and inner bottom of the embankment. If the ſoil is ſtrong, one foot or eighteen inches will be ſufficient for this *berme*; if it is looſe or ſandy it will require at leaſt three or four feet *."

* Beatſon in Communications to the Board of Agriculture, Vol. II.

The more gradual and eaſy the external ſlope is made, the reſiſtance againſt the ſea will of courſe be the leſs ſudden, and the embankments leſs liable to injury: this ſlope muſt therefore be made according to its expoſure to the winds and tides; but nothing can be a greater error than to make it too bold or upright*." See Plate XXXVIII. *Fig.* 1. "The inſide ſlope ſhould alſo be faced with turf, which may be laid with the green ſide downwards, as in building any common ſod wall. Some expert ſodders can finiſh this kind of work extremely neat, by ſetting the ſod on edge, according to the ſlope intended to be given, and with proper mallets and beetles ram the earth hard behind, which conſolidates the work as it advances, and tends very much to its durability. When the firſt or lower courſe is finiſhed, they pare the upper edge of the ſods with a ſharp knife quite even by laying a rule to them; and then they go on with the ſecond courſe, which they finiſh in the ſame manner, and ſo proceed till the whole height is completed; which, when finiſhed properly, looks very beautiful and ſmooth, not a joint between the turfs being ſeen. If turf is to be uſed in covering the outſide ſlope, it muſt all be laid with the graſs uppermoſt, and well beaten down with a flat ſod beetle for that purpoſe; and for their better ſecurity it may not be amiſs to drive a ſmall ſtake, of about eighteen inches long or more, through every ſod. The ſods for this purpoſe ſhould at firſt be carefully taken up and traced by a line, all of the ſame breadth, and their edges cut as even as poſſible, that they may make the cloſer joints, which will tend very much to their ſecurity till they grow properly together. In laying the different courſes of theſe ſods, care ſhould likewiſe be taken that the joints of the one are covered by the other, in the way that good brick-work is made."

If it be propoſed to reclaim a piece of land upon which the ſea ebbs and flows every tide to a greater depth than in the foregoing caſe, as in a creek, or on the ſide of a large river, a different mode of proceeding, it is obſerved, muſt be adopted according to the ſoil and to the materials intended to be uſed. "If there are plenty of ſtones to be eaſily had, a bulwark may be formed of theſe, with a mixture of clay, either by land-carriage, or (which in ſome caſes is preferable) by carrying them in flat-bottomed boats, or punts, and throwing them overboard till a bank is accumulated. If ſtones cannot ſo eaſily be had, a quantity of clay, or other materials fit for the purpoſe, thrown in in the ſame manner, may anſwer equally well. It is ſuppoſed that moſt of the embankments in Holland were done in this manner, by carrying the clay dug out of the canals in boats, and throwing it into the water. In either caſe it is neceſſary to fix up ſtrong poles before the work is begun, as guides for laying down the materials. Sluices are alſo requiſite at certain places to let out

* Beatſon in Communication to the Board of Agriculture, Vol. II.

the back water when the tide ebbs; but the poſition and conſtruction of theſe depend ſo much on local circumſtances, that the engineer who conducts the work ought to be the beſt judge where and how to form them. A great deal depends on a ſkilful engineer in works of this kind, who will contrive many ways to facilitate the work, and to overcome all difficulties in the execution of it." *

The following "ſpecies of ſea-embankment is perhaps the moſt important of any; for there are few eſtuaries, or mouths of rivers, where large and valuable tracts of land may not be gained by ſuch means. The ſhoals, or flats formed at the entrance of ſuch rivers, are often compoſed of the richeſt manures or moſt fertiliſing particles, brought down by the ſtream from the towns above, or from the adjacent country through which the river flows. Theſe ſhoals may therefore, by proper management, be in general very eaſily converted into the moſt fertile plains. Where ſuch a ſituation happens, the firſt object is to collect the whole river into one ſtream, and to prevent its overſpreading a wider extent than juſt ſufficient for its diſcharge; or, perhaps, it may be better to alter the courſe of the river altogether, and to make it diſcharge itſelf at ſome other place. The principle upon which that idea is founded, is this:—It has been obſerved, and proved by experience, that if the courſe of a river or ſtream be altered in ſuch a manner as to make it diſcharge itſelf into the ſea at a different place than it did before, the former place will in a few years, by the conſtant accumulation of ſand or mud brought in every tide, be ſo choked up or raiſed above its former level, as to form of itſelf, in proceſs of time, a bank that, with a very little aſſiſtance, will quite exclude the ſea: for as the current of the river before carried away all that ſediment which the motion of the waves naturally ſtirred up, the current being removed, all or moſt of the muddineſs will not only be carried further up the old channel of the river, but a great part of it be depoſited there as the tide recedes. It has even been obſerved, that in ſpring-tides and particular winds this ſediment is depoſited in greater quantities than at other times; and Mr. Beatſon has been informed that on making a perpendicular cut in the land ſo gained, the different ſtrata or layers were ſo diſtinct, that thoſe made at ſpring-tides could eaſily be diſtinguiſhed from the reſt. This is a very curious fact, and well worth the attention of all who have lands ſituated at the mouths of rivers, as there may, in many ſuch places, be conſiderable tracts gained in this manner at a very ſmall expenſe. Although this fact may be proved by experience in ſome places, nevertheleſs he ſhould imagine the effect would not be the ſame in all ſituations. Where there is a great extent of flat or muddy ſhores, the motion of the waves

* Beatſon in Communications to the Board of Agriculture, Vol. II.

will no doubt ſtir up the mud or ſand, and carry great quantities of them along with the current on the flowing of the tide; and when the tide ebbs, although ſome of the lighter particles will be carried away again, yet it is natural to ſuppoſe the heavier ones will be left behind. If the ſhores are bold and rocky, except juſt near the entrance of the river, there will be the leſs of this mud; but, indeed, on ſuch ſhores there can be little or no occaſion for embanking, unleſs, perhaps, in ſome creeks, narrow at the entrance and ſpreading wide above. From ſuch creeks, if the ſea were excluded, a great deal of land might probably be gained*."

It is remarked, that "embankments againſt rivers may be divided into two ſorts; namely, thoſe for preventing their encroaching on the adjacent lands, and for protecting thoſe lands and the neighbouring level country from being overflown when the water riſes above its ordinary level. It may be obſerved, that where the courſe of a river is a ſtraight line, or nearly ſo, it hardly ever makes any encroachment upon its banks, unleſs, perhaps, in very large rivers, when they riſe above their common level either owing to an increaſe in the waters, or to their being in ſome degree affected by the tides. In either caſe the waves occaſioned by a ſtrong wind, where the river is wide, will moulder away the banks on that ſide upon which it blows, unleſs prevented in proper time. This may be done either by ſecuring the bank properly with ſtones, or by driving a row of long piles pretty cloſe together, at a little diſtance from the ſhore; the piles being of ſuch a length, and ſo driven, that their tops may be always above the higheſt riſe of the water. It is ſurpriſing the effect that piles driven in this manner have in reſiſting the power of waves. Some years ago, when on duty as an engineer at a fort near Portſmouth, built on a point of land much expoſed to the ſea, the waves made ſuch havock that the walls on that ſide were conſtantly giving way although built in the moſt ſubſtantial manner, and having bulwarks of large heavy ſtone beſides to protect the foundation: however, all would not do; thoſe bulwarks were ſoon knocked to pieces, and ſeveral times the wall itſelf. At length it was propoſed to drive a number of piles at about forty to fifty yards from the fort. Thoſe piles were twelve or fifteen inches in diameter, and driven about one diameter from each other, nearly in a ſtraight line, parallel to the wall where the waves did ſo much damage. They were driven into the ground with a pile engine till perfectly firm, perhaps eight or nine feet deep, and about two feet of the top of them left above the level of high water mark. After this was done the walls received no further injury, the ſpace between the piles and the fort being always perfectly ſmooth however tempeſtuous the waves

* Beatſon in Communications to the Board of Agriculture, Vol. II.

might be without. The ſame ſimple method might ſometimes, perhaps, protect the banks of large rivers expoſed to the waves when other methods fail*." But "the moſt common cauſe of rivers' encroaching on their banks is, the reſiſtance occaſioned by a ſudden bend. In flat countries, apt ſometimes to be overflown, where there are any ſuch bends or windings in the rivers, it would be of great advantage to ſtraighten the courſe as much as poſſible; for as every impediment or obſtruction will naturally cauſe the water to riſe higher than it otherwiſe would do, and as ſuch bends have that effect, conſequently in the time of a flood the waters will overflow a greater extent of country, and to a greater depth, than if the river had a free and uninterrupted courſe ſtraight forward. If the windings of the river cannot be altered, and that encroachments are making on ſome part of the banks, it muſt firſt be conſidered whether the force of the water can be diverted to another place where no injury can be done†." See Plate XXXVIII. *Fig.* 2. On the river Nith, in Dumfrieſhire, it is obſerved, "a good deal has been done in this way by Mr. Millar, of Dalſwinton. See Plate XXXVIII. *Fig.* 3. As the river was encroaching moſt rapidly, and ſeemed inclined to take a new courſe, which would have deſtroyed ſome very fine land, and done a great deal of miſchief in that part of the country—To prevent this, Mr. Millar made a large cut about four hundred yards in length, and threw in a great quantity of ſtones quite acroſs the river to direct its courſe in a ſtraight line. This had in a great meaſure the deſired effect, by totally preventing its progreſs; but now it began to encroach on its banks at another part. He at firſt endeavoured to prevent this by driving in, at a conſiderable expenſe, a number of piles at a little diſtance from the bank, and wattled them with willows, branches, &c. thinking thereby to protect the bank. The piles were drove in with heavy mallets, apparently firm into the ground; they continued ſo for ſome months till a heavy fall of rain came on, which ſwelled the river, undermined the piles, and carried them all away. But it is in vain to think of piles doing any good in ſuch a ſituation unleſs firmly driven in by a pile engine, for it is not poſſible to drive them in properly with mallets. This muſt have been the cauſe of their giving way ſo very ſoon. The piles not ſucceeding, he was reſolved to try another plan. Several of his adjacent fields being covered with an immenſe quantity of ſtones, he ordered them to be gathered and thrown into the river, ſo as to form a jutty a little way above the injured bank. Being obliged to go from home about that time, and leave the execution of the work to ſome country people, they carried out this jutty too much at right angles to the ſtream; it had

* Beatſon in Communications to the Board of Agriculture, Vol. II. † Ibid.

not therefore the defired effect, but rather made the matter worſe than before; for if a jutty is carried out at right angles, the current will be forced to the oppoſite ſide of the river, and thence it will rebound more violently than it did before. But if a jutty is placed obliquely, it will force the current gradually on the other ſide, in which poſition one jutty may do more good than ſeveral placed improperly at right angles. He was therefore under the neceſſity of making other jutties in this way, and has now the ſatisfaction to find that they anſwer the purpoſe intended. Thoſe he made laterally formed a ſort of convex ſlope, the convexity being parallel to the current. Strong planks were alſo firmly ſet on edge among the ſtones, their ends pointing towards the river; ſo that if ever any current came ſo rapid as to move any of the ſtones, it muſt move them all in a body the whole length of the plank. Perhaps this precaution was unneceſſary; for although ſtones are thrown into a river looſe in this manner, the ſluſh, ſand, &c., that come down the river, will ſoon fill up all the cavities, and render it as firm and ſolid as a regular built wall *.

"The next ſort of embankments againſt rivers are, it is obſerved, thoſe to prevent them overflowing their banks, and inundating large tracts of country. This may be conſidered as the ſimpleſt and eaſieſt of all ſorts of embanking if judiciouſly executed. It is therefore the more inexcuſable to ſee in ſome places extenſive tracts of the richeſt meadows completely overflown by every flood. Few ordinary-ſized rivers riſe more, even in the greateſt floods, than five or ſix feet above their common level, unleſs when they meet with ſome conſiderable interruption or confinement in their courſe. But if interrupted or confined, they will riſe perhaps twenty feet or more. If, for example, a given quantity of water is ſix feet deep when running over a ſpace twenty feet wide, it is clear if that ſpace were made only ten feet wide the water would riſe to twelve feet; and if it were made forty feet wide, the ſame quantity of water would riſe only to the height of three feet. It is therefore of great conſequence, in preventing inundations, to give the river as much width as poſſible, by widening every narrow place. All kinds of obſtructions ſhould alſo be removed, whether occaſioned by windings, ſhoals, ſtones, trees, buſhes, or any thing elſe. In ſome caſes this may even preclude the neceſſity of embanking; but where embanking is neceſſary, let the banks by all means be at a ſufficient diſtance from each other to contain with eaſe between them the largeſt contents of the river in great floods. The diſtance and height of the banks may eaſily be aſcertained by meaſuring a ſection of the river when at its higheſt, or when the flood-mark is viſible. Where a ſufficient diſtance is allowed between the embankments, their height need not ex-

* Beatſon in Communications to the Board of Agriculture, Vol. II.

ceed from four to ſix feet. If irremovable obſtacles are in the way which cauſe the river to riſe higher, the banks muſt be higher in proportion. In either caſe, however, the ſlope of theſe kinds of banks on each ſide may be equal to its perpendicular height, and the breadth on the top about one-third of that height; which, ſuppoſing the bank ſix feet high, the baſe would be fourteen feet, and the breadth of the top two feet. See Plate XXXVIII. *Fig.* 5. The materials for making theſe banks ſhould be taken as much as poſſible from the ſides of the river, which will have the double effect of widening the river and forming the embankments; and there ſhould be a trench on the inſide (from which materials may alſo be got), with ſome ſluices, as formerly directed, to drain off any water from within; alſo ſluices to let in water from the river, if required, which would very much fertiliſe the meadows if properly laid out for that purpoſe*."

Farms ſituated on the borders of rivers are often liable to injury and inconvenience from them in different ways; as from part of the ſoil being carried away in times of flood, from the rivers overflowing their banks, and from the rivers in times of flood flowing back into the channels of the rivulets and ſtreams that conduct the water from the more elevated and diſtant grounds to the rivers, whereby theſe rivulets and ſtreams are made alſo to overflow their banks. The danger of the ſoil being carried away in time of floods is increaſed or decreaſed according to circumſtances; as the form of the banks, the nature of the ſoil, the rapidity of the river, and the quantity of the water that lodges on the margins of the banks or falls over them into the river. Where the banks of a river are perpendicular, if the ſoil be of a ſandy or rich mouldering nature, the danger of part of them being carried away by floods is greater than where they ſlope gently from the ſurface of the field to the bed of the river, which when they do not they ſhould be made ſo. But if the ſoil and ſubſoil be an entire maſs of clay or ſtrong loam, and the current of the river do not preſs more upon one part than another, a ſubſtantial improvement may be effected by ſloping the bank ſo that the declivity may be one foot in three or four from the ſurface of the field to the bed of the river. And where gravel mixed with ſmall ſtones can be conveniently procured, ſpreading theſe materials on the ſloping bank, to the depth of eight or ten inches beyond the flowings of the river, may prove a good ſecurity againſt further damage; and if the bank be planted thickly with any ſort of willow, it will in a ſhort time become an impenetrable fence, and the annual cuttings of wood ſoon be equal to the value of the

* Beatſon in Communications to the Board of Agriculture, Vol. II.

land thus occupied. Where no gravel can be procured, the new ſloped bank ſhould be immediately covered with well ſwarded turf, which ſhould be beaten down as hard as poſſible, either by the back of the ſpade or with wooden mallets. If this be done in the beginning of ſummer, and willows be planted the following autumn, the improvement may be effectual and permanent. In order to prevent the effects of a current againſt a particular part of the bank, a fence or bulwark of ſtone in the front of the place may be neceſſary; the beſt way of doing which is, to drop the ſtones in a careleſs manner, but ſo as they may lie cloſe together on the ſloped bank, care being taken to lay them all the way from the bed of the river, till conſiderably beyond where the river flows in common. In level, or nearly level diſtricts, all that is neceſſary is to ſecure full ſcope for the rivers to overflow their uſual bounds without interruption: when that is ſecured by either of the methods before mentioned, floods, unleſs very violent, ſeldom do any material damage to the banks of rivers in ſuch ſituations. It is in many caſes extremely difficult to guard rapid running rivers in ſuch a manner as to prevent part of the banks from being carried away by inundations. Neither ſloping the banks nor ſtrong bulwarks made of ſtone would here be effectual; the method of filling a ſort of large open baſkets, placed along the bottom of the banks, with ſtones, has been found ſucceſsful, and, as theſe baſkets may be made to contain two or three tons of ſtones, it can only be on few occaſions, and in very particular ſituations, that they can be diſplaced or carried away. Much damage is often done to the banks of rivers in level diſtricts, eſpecially if the banks be perpendicular and of a conſiderable height, by allowing the land-floods to fall over them into the rivers. As the water from the furrows approaches the bank it is frequently ſtopped in the furrow of the head-ridge, which becomes for a time a kind of reſervoir; the conſequence of which is, that a conſiderable proportion of the water ſinks and filtrates through the earth, which, being thus ſoftened and ſwelled, is more eaſily undermined and carried off by the river. Sometimes little cuts or openings are made from the furrows acroſs the head-ridge for the purpoſe of conducting the rain-water into the rivers, the conſequences of which are equally bad; as at every one of theſe cuts or openings a little creek is formed, in conſequence of the bank having been more ſoftened, and by that means having become a more eaſy prey to the rivers when in flood. To prevent theſe evils, it is neceſſary, beſides ſloping the banks, to devote a part of the lands adjoining, to the breadth of twenty or thirty yards, either to paſturage, or the growth of trees; and to form a drain at a proper diſtance from, and parallel to, the bank for the purpoſe of collecting and carrying off the

water from the furrows. By this means, and conducting the water from this drain into the rivers by conduits, formed a little above their ordinary levels, much land which is annually loſt would be preſerved*.

Various injuries happen to the farmers in level tracts, where the banks of the rivers are low, and where the courſes are not of ſufficient breadth to contain the water in time of flood. By forming mounds of earth, the ſides of the drains propoſed to be made for carrying off the land-water being well ſloped on the ſides towards the rivers, the rivers would be prevented from doing injury to the adjoining lands; as by theſe mounds being placed at a diſtance from the river, the force of the ſtream would be much leſſened, and the natural boundaries of the rivers greatly enlarged. And where injury is ſuſtained by the rivers during floods flowing back into the channels of the ſtreams that bring the waters from the more elevated grounds, the beſt method is to erect mounds at a diſtance from the banks, and of a ſize proportioned to the quantity of water which, from the cauſe now mentioned, may be ſuppoſed at any time to ſtagnate in theſe channels. This may be done at a very trifling expenſe either in money or land. If the proprietors do not chooſe to ornament the country and improve their eſtates, by planting trees on the borders, the farmers may ſo conſtruct the mounds as that they may become fences to their arable fields, while the portion of land cut off may be devoted to paſturage †.

Where the water coming from the hills or high lands are conſiderable, and the courſes of the rivers extremely ſerpentine, ſo as to produce much injury on the flat lands below by the ſtagnation that is produced, advantage may be derived in other ways, as by ſtraighteningthe courſe of the rivers, and interrupting the water coming from the high lands above them, by cutting proper drains and channels along the face of the declivity as ſhown in Plate XXXVIII. *Fig.* 6. ‡

In embanking againſt lakes, it is obſerved that "as the waters ſubſide greatly in the ſummer ſeaſon, and riſe conſiderably in winter, or when the ſeaſon is wet, advantage may in ſome caſes be taken to confine them within their ſummer limits, or at leaſt to cut off ſome of their branches or creeks. When either of theſe is to be attempted, the principal outlet muſt firſt be examined, and that ſhould be enlarged and widened conſiderably, which, upon the ſame principle as already mentioned reſpecting the widening of rivers, will prevent the water riſing ſo high as formerly. If the levels will not admit of much depth being got, or if the ground is rocky, and would be difficult and expenſive to deepen, let the breadth be increaſed as much as poſſible, and

* Modern Agriculture, Vol. IV. † Ibid.

‡ Farmer's Magazine, Vol. II. p. 119.

every obſtacle cleared away, that the water may run freely into a ſhallow ſtream. If it is required to aſcertain exactly, or to fix the future limits of the water, a ſection of the greateſt quantity running out during a flood ſhould be taken. Suppoſe this ſection, for example, ten feet wide and four feet deep; by making it 40 feet wide, the ſame quantity of water will not riſe above one foot: conſequently, by this means alone, three feet in height will be gained all round the lake, which, in caſe of embanking it, would be a very great object*."

The ſummer ſeaſon is the beſt time to carry on theſe as well as other embankments; but when materials are to be brought from a diſtance, they may be laid down or prepared at other ſeaſons, excepting the turf, which ſhould always be uſed as ſoon as poſſible after it is cut. The manner of conſtructing embankments of this nature is the ſame as in other caſes. The methods employed in making embankments againſt the ſea on the eſtate of Lord Galloway are repreſented in Plate XXXVIII. at figs. 7, 8, and 9. They were formed to the heights of three and a half and five feet, having the breadths of ſix feet and five feet at the baſes, and 20 inches at the tops. They were conſtructed almoſt wholly of turfs or ſods, with only a little well beaten ſtuff in the middle of one of them; and with two ſmall drains, one on each ſide, about two feet in depth, coſt about 3d per yard. In executing all ſorts of embankments, the greateſt care ſhould be taken to make them perfectly firm and water-tight, by conſtantly beating and ramming them well while they are forming.

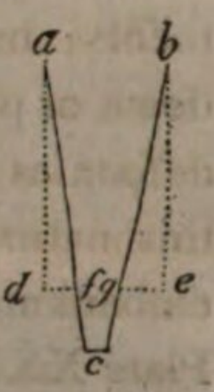
To be read after Line 22, *Page* 216.—It has been ſuggeſted that the oily particles with which the fleece of ſheep is charged, exſuded without doubt from the animal, though an imperceptible, may probably be a powerful manure; when ſheep lie down, this animal exſudation may be abſorbed by the ſoil. It might be worth inveſtigation, whether this ſecretion be more copious in one breed of ſheep than another; and whether it equally abounds in the fine ſhort fleece of the Norfolk breed as in the coarſer but more ample clothing of the Leiceſter, South Down, &c. To the oilineſs of their fleeces may alſo perhaps be attributed the great injury which ſheep commit on young trees, by rubbing themſelves againſt the bark.

To be read after Line 32, *Page* 290—The ordinary method of forming theſe ſuperficial drains is to excavate channels in the form of a wedge, that is to ſay, with the

* Beatſon in Communications to the Board, &c. Vol. II.

ſmooth ſides narrow at the bottom and diverging towards the ſurface of the earth: thorns and ſtraw are then ſtamped firmly in with the foot, and the drains are covered over with mould. Unleſs the ſoil be very ſtiff and tenacious, the ſides of the drains are very liable to be torn by the force with which the thorns are preſſed in; and the channel, which ought to be preſerved quite open at the bottom, oftentimes half choked by the looſe earth which crumbles in. Inſtead, therefore, of forming the drains in the ordinary ſhape, it is perhaps better to make a ſhoulder for the thorns to reſt on; thus,

ac and *bc* repreſent the ſmooth ſides of an under-drain, as it is uſually formed:—rather than form the ſides thus approaching to each other at the bottom, it is *perhaps* better to cut down perpendicular the two dotted ſides *ad* and *be*, leaving the ſides, and the ſhoulders *df* and *ge* for the thorns to reſt on. Below this ſhoulder the water has an uninterrupted channel for its courſe. At the mouth of the drains, that is, where they diſcharge themſelves into the ditches, it is adviſable to lay a ſmall plank transverſely. Sheep in the ſummer time run into ditches, and without ſome ſuch preſervative as this, they are likely to ſcratch a quantity of mould into them.



The advantages of draining have been exhibited with ſingular effect in the neighbourhood of Eaſt Devon. Mr. Munning informs us, that at Michaelmas, 1795, Mr. Salter of Winburgh entered upon the occupation of more than eight hundred acres of *heavy* land, which had been ſo entirely neglected by his predeceſſor, as to be almoſt altogether what it ought *not* to have been.

Mr. Salter immediately ſaw, that unleſs he could get rid of the ſurface water all his labour muſt be fruitleſs, and his money expended in vain; he therefore began his operations by cutting 342 rods (of 7 yards to the rod) of *river* through the centre of the farm, 7 feet wide and 6 feet deep perpendicularly, in order to obtain an outlet for the water to flow from his other works: he cut 2937 rods of new and old ditches, 6 feet and 5 feet deep perpendicularly; 1116 rods of open drains, of various widths and depths, from 4 to 5 feet wide, and from $3\frac{1}{2}$ to $4\frac{1}{2}$ feet deep perpendicularly; and he cut and filled up 4871 rods of under-draining, of which the leading drains were 36 inches, and the feeding drains to the ſame 30 inches deep perpendicularly. The whole of this work was executed and completed in one year! Mr. Salter has continued to do a great deal every year ſince 1795: between Michaelmas 1800 and Michaelmas 1801 he executed 4423 rods of under-draining of widths and depths as before expreſſed; and he is now going on with the ſpirit and the judgment of an experienced and an underſtanding agriculturiſt. The effect has been, that on the

land which was ſo much impoveriſhed by ſtagnant water, and ſo much inundated by land-ſprings, as not to reproduce the ſeed uſed upon it, his crops have been abundant; and while Mr. Salter reaps the benefit of his judicious exertions, he may very fairly be regarded as a public benefactor. He may almoſt be conſidered as producing a new creation around him, and ſhould be held up, by every friend to agricultural improvement, to the admiration and the imitation of all who have to do with heavy land from which it is neceſſary to remove the ſurface-water*.

To be read after Line 31, *Page* 326.—Straw alone muſt, however, often be inefficacious, as there is no ſoil ſo tenacious as not to be liable to crumble. Froſt penetrates deeper into wet lands than dry ones: evaporation is greater in the former caſe than in the latter, and heat is evolved with more facility. Many of the eſtimates of the expenſes of draining, from the great riſe in the price of labour, are conſiderably lower than the preſent prices.

To be read after Line 2, *Page* 368.—In Norfolk they occaſionally make what is called a *baſtard ſummer-till.* If a piece of land, from which they have mown a crop of clover or any artificial graſs, appears to be not ſufficiently clean for the enſuing wheat-crop, they plough it twice, and, if there is time, thrice before harveſt, uſing freely both the roller (if it is neceſſary) and the harrow. They ſometimes even make a *baſtard* ſummer-till of a pea-ſtubble, for the purpoſe of cleaning it. As ſoon as the peas are off the land, which oftentimes happens four or five days, and ſometimes a week, before the harveſtmen are taken home, they harrow the haulm up and cart it off; plough the land once immediately, and let it lie till harveſt is over; then give it two croſs ploughings, and a fourth preparatory for ſeed, which, however, is oftentimes ploughed in with the laſt earth.

To be read after Line 5, *Page* 541.—The Rev. Dr. Pike has ſtated, upon the conviction of many experiments, that wheat will thrive as well, and produce as full a crop, if ſown in the ſpring, as if it had been committed to the ground the autumn before; and in many ſituations he is of opinion (where it is ſubject to much wet during the winter) the crop will be much better in quality and more abundant in quantity. "I have frequently ſown," ſays he, "in the ſpring both the white and the Kentiſh red wheat, ſometimes as late as the middle of March, and never had a

* Munning on the Culture of Turnips.

crop fail that was ſown at that time: nor have I ever found any conſiderable difference in the times when the autumnal and the ſpring crops ripened."

Dr. Wilkinſon, of Enfield, an intelligent agricultor, recommends the cultivation of ſpring-wheat, as a ſpecies of grain which, although ſown ſo late as the 11th of May, he has found, by experience, to ripen with the autumnal wheat. He obſerves that ſpring-wheat was known to the Romans as a ſpecies diſtinct from the common wheat, and deſcribed as ſuch by Columella, who conceived it very acceptable to the farmer, when, on account of floods, or rains, or other cauſes, he had been prevented from ſowing the autumnal kind. And Mr. Dickſon, in his account of the Agriculture of the Antients, took it for granted that it had never been cultivated in England, and expreſſed a wiſh that the experiment might be made. He conſiders it as well adapted to the wet climate of Scotland, where, owing to heavy rains, the farmers are frequently reſtricted in regard to the quantity of wheat that can be ſown. Common wheat, he ſays, has been ſown in ſpring in Scotland, but has frequently failed. By Linnæus it is termed *Triticum æſtivum*, ſummer or ſpring wheat.

It has four flowers in the calyx, three of which moſtly bear grain: the calyxes ſtand pretty diſtant from each other on both ſides of a flat ſmooth receptacle. The leaves of the calyx are keel-ſhaped, ſmooth, and they terminate with a ſhort ariſta. The glumes of the flowers are ſmooth and bellying, and the outer leaf of the glumes in every calyx is terminated by a long ariſta; but the three inner ones are beardleſs. The grain is rather longer and thinner than the common wheat. It is ſuppoſed to be a native of ſome part of Tartary*.

Mr. Ray alſo, he ſays, claſſes it as a diſtinct ſpecies. It is generally ſuppoſed to have been introduced into this country about the year 1773, under the name of Siberian wheat, Switzerland wheat, or *bled de Mars*. It is however mentioned by Harriſon, an hiſtorian in the time of Elizabeth, though he ſays it was known only to few huſbandmen.

In Doſſie's Memoirs of Agriculture and other Œconomical Arts, Vol. III. a detail, the Doctor obſerves, is given of ſome experiments on the cultivation of this wheat, communicated by ſeveral gentlemen, to the Society of Arts. The obſervations there recorded, he ſays, agree with his own experience. The lateſt ſown, however, was the latter end of April; the produce is ſtated at three and two quarters per acre. The experiments ſeem to agree in deciding, that no advantage was gained by ſowing it early. Wheat ſown in April ripened as early as what had been ſown the beginning of March.

* Bryant's Flora Diætetica.

That it does not tiller like common wheat, but ſhoots up immediately from its firſt appearance above ground. That the grains are ſmaller than common wheat, but increaſe in ſize when ſown on rich land. That it is liable to the ſmut. That it would ſucceed in the fens and low lands, which are ſubject to winter-floods. That it would be worth trying in the mountainous parts of Derbyſhire, Yorkſhire, &c. where little or no wheat is ſown, the ſituation being too cold for wheat ſown in the autumn to ſtand the ſeverity of winter, froſts, and rain, without periſhing. In the firſt volume of the Tranſactions of the Society of Arts, Sir Wm. Fordyce, he remarks, gives an account of an experiment on ſpring or Siberian wheat, in which two buſhels of wheat produced two quarters of grain. It was ſown the beginning of April, after turnips, and was found to prove an excellent nurſe of clover and rye-graſs, ſown at the ſame time. The turnips had been drawn, and not fed-off by ſheep. The ſoil a mixture of gravel and clay. And in the Annals of Agriculture, Vol. VII. and X., ſome important experiments on ſpring wheat are recorded by Mr. Ruggles, of Clare. Seed two and three buſhels per acre; the produce from two to three quarters. Time of ſowing the end of March. Mr. Ruggles obſerves, that this wheat is apt to receive injury from froſt and dry weather. That it requires a dry mouldy ſoil; if moiſt, ſo much the better; but he does not conceive the crop equal to ſpring corn, unleſs the price of wheat ſhould exceed the average difference between that grain and barley, or when, from an uncommon quantity of rain in autumn, the wet lands may not have been ſown. The weight ſixty-three pounds and a quarter each buſhel, containing eight gallons three pints. Mr. Ducket, the Doctor ſays, has cultivated ſpring-wheat on a large ſcale. He drills two buſhels per acre, about the middle of March. He has grown it on the ſame land for three years ſucceſſively. He has reaped this wheat on the 25th of July, got in turnips, and then wheat again in ſpring. And Mr. Marſhall, in his Survey of the Midland Counties, remarks, that ſpring-wheat is cultivated and approved of in that diſtrict. It was likewiſe ſtated in the General Evening Poſt of November 12th, 1800, that in an account of an experiment made that year on the genuine ſpring-wheat: —A perſon at Bridgenorth ſowed ten acres with the above wheat on the 29th and 30th of April, which produced on the average more than twenty-one threaves, common-ſized ſheaf, per acre; and, from a trial made of its produce, yielded more than ſixty quarts of fine wheat per threave. Seven acres was a two-year old clover-ley, cold clay land, ploughed more than ſeven months before ſowing. Four acres of the above ſeven were manured with four hundred buſhels of lime before ſowing, the other three with one hundred buſhels of ſoot ſix weeks after.

The remaining three acres were ſown on rather light land after turnips. The whole ſown on one ploughing, and houſed early in September.

The reſult of the Doctor's extenſive experience on the cultivation of ſpring wheat, is as follows:—1. That it is a diſtinct ſpecies of wheat, as obſerved by Columella, Linnæus, and Ray. He has ſown it in ſpring, at the ſame time, and in the ſame field, with common wheat. The common wheat failed, while the ſpring-wheat roſe to a crop. 2dly, That being liable to be hurt by the froſt, no advantage is gained by early ſowing. That though the proper ſeaſon may be about the middle of April, yet it may be ſown ſo late as the 15th of May, as he found by experience laſt year, when, notwithſtanding the unfavourable ſeaſon, it ripened before barley ſown at the ſame time, and on the ſame field, and was cut on the 20th of September, immediately after the autumn-ſown wheat; the crop two quarters per acre. 3dly, That about two buſhels may be the proper quantity of ſeed per acre; when drilled, leſs; his has been ſown broad-caſt. That the average produce may be about two quarters per acre, unleſs when ſown after turnips fed off by ſheep, when he has gained three quarters per acre. 4thly, That the average value may be about 1s. leſs per buſhel than the common wheat. He ſold this year the ſpring-wheat at 10s. while 11s. was given for the common ſort. 5thly, That being a ſmaller grain than the common wheat, it ripens earlier and with leſs ſun: in a wet harveſt, therefore, it dries ſooner for grinding, as he experienced laſt year. That it receives but little injury from a wet ſummer and autumn, but will ripen earlier than barley in ſuch a ſeaſon. And, 6thly, That when harrowed in on autumn-ſown wheat, in places where the crop has failed, it will ripen at the ſame time without injuring the ſample; which would not be the caſe with either barley or oats. It may therefore, he thinks, on a large farm, deſerve the attention of the huſbandman, and be worth his while always to cultivate a ſmall quantity, as the beſt means of reſtoring a thin wheat crop.—Magazan beans, when dibbled in, will anſwer the ſame purpoſe, but perhaps not equally well, as they may be longer in drying than the wheat*.

But though Dr. Wilkinſon recommends the *Triticum æſtivum* as beſt adapted for ſpring culture, Dr. Pike thinks that in ſome northern parts of the iſland, where the common wheat is generally found to fail when ſown in ſpring, it may probably be ſo: but continues his aſſertion that he has *repeatedly* ſown both the common red or Kentiſh wheat, and the white, *in the ſpring*, and had excellent crops. Dr. Pike has not, however, mentioned the nature of his land.

* Monthly Magazine, Vol. IX. p. 244.

The former of the above writers has likewiſe given ſome uſeful obſervations, the reſult of his own experience, on the nature and cultivation of another kind of wheat, uſually known by the title of *Egyptian* or *Prolific wheat*, though little attended to by writers on huſbandry. He found the firſt year, on three acres of moiſt loam, which had been previouſly fallowed, that nine buſhels of ſeed produced nine quarters of wheat. In the ſame field, after a ſimilar preparation, the ſame proportion of white wheat, ſown at the ſame time, produced three quarters four buſhels per acre. In both caſes the fallow was dreſſed with about one hundred buſhels of lime per acre, at 7d. per buſhel delivered. Four buſhels of the Egyptian wheat, though weighing four pounds more than the ſame quantity of white wheat, yet produced twelve pounds leſs of flour, the bran being coarſer and heavier.

After the month of May the growth was more rapid than that of common wheat; on which account, he ſhould ſuppoſe it might be ſown with advantage in ſpring. The enſuing ſpring will preſent a fair opportunity for the trial. The ſtraw ſo nearly reſembles a reed, that it has been called reed wheat. Being heavy and tough, it is cut with difficulty; on which account the reapers require an extraordinary price. It is excellent for thatching, and he has employed it for this purpoſe on a large hay-barn. The truſſes, on account of their weight, would appear ſo ſmall that the ſtraw would not be ſaleable in the London market. The ears are bearded like the cone wheat, but in ſhape reſemble the ſquare wheat or rivet. The length of the ſtraw and weight of the ear make it liable to lodge.

"On expoſing it to ſale, he found the millers not inclined to purchaſe it. They complain that it is of too horny a nature; that it grinds hard, and obliges them to ſet their ſtones too cloſe. The flour is coarſer and darker than that of the common wheat. A miller who purchaſed ſome was charged by his cuſtomers with grinding rivets. Great part of the crop ſold at a price but little above that of good barley. As the crop, though apparently thin on the ground, had yielded three quarters per acre, he entertained hopes that the cultivation might anſwer, even at the price of barley,—if on lighter land, and a warmer ſoil, he could ſecure a larger produce. With this view, therefore, the following year, he ſowed on a lighter loam two acres with this wheat, and the remaining ſix acres of the field with the common red wheat: the whole on a clover ley. The produce of the red wheat was three quarters per acre, but of the Egyptian not above two quarters per acre; and he found great difficulty in diſpoſing of it even at the price of barley. He concludes, therefore, that this wheat will not anſwer in this country, where wheat of a ſuperior quality can be cultivated to advantage, unleſs it can be introduced

as a ſpring corn. He has ſince met with an account of this grain having been ſown in the ſpring as Egyptian or Siberian barley, under which name it was introduced into this country in the year 1767 *.

The Rev. Dr. Pike has ſown it as ſpring corn in the middle of April, and has had above four quarters per acre. It was on very good land, and kept perfectly clean from weeds. If it be truly a native of Egypt, he ſhould have judged, that a light but very rich ſoil might have been moſt proper for it: nevertheleſs, he thinks he has found, that (like Engliſh rivets) ſtrong land ſuits it beſt. It gives a very bold, plump, ſound grain, of a good colour. He cannot think that it is the ſame as the Siberian wheat (or barley, as ſome have called it). The grains do not anſwer the deſcription which ſome authors give of that ſpecies. That was, he ſays, introduced into this country about the year which Dr. Wilkinſon mentions; but this was known here at leaſt above 120 years before; for he has found a ſhort deſcription, and a tolerably good figure, of it in Parkinſon, page 1120, under the name of *Triticum multiplici ſpicâ*. In the figure, its very remarkable diſtinction from all other ſorts is well expreſſed, by a number of ſhort ears growing out of the ſides of the chief ears. He calls it in Engliſh double-eared wheat, and ſays that it grows about *Lyons* in France†.

To be read after Line 25, *Page* 541.—In Norfolk, wheat is ſeldom ſown after the preparation of a complete ſummer fallowing; there, wheats almoſt invariably ſucceed clover, unleſs a pea or bean crop be interpoſed, and the land is ſcarcely ever fallowed for it, except in the caſe mentioned in note on *baſtard ſummer-tills*.

To be read after Line 8, *Page* 543.—In Norfolk, however, they are in the conſtant habit of ſetting wheat upon a pea-ſtubble with a ſingle ploughing, and conſider it very ſafe and excellent huſbandry: the pea-crop ought to have been kept clean, and, after it is harveſted, the haulm harrowed off. They never plough a bean-ſtubble more than once.

To be read after Line 15, *Page* 550.—An intelligent farmer in Norfolk had, in the year 1800, a piece of drilled wheat, conſiſting of nearly eight acres and a half, unſeeded by the careleſsneſs of his man. The vacant places were dibbled, but to no purpoſe; the vegetation was ſo languid, that, in the courſe of

* Monthly Magazine, Vol. XVI. p. 132. † Ibid.

the winter, all the young ſprouts died, or were eaten up by vermin. On the ſecond of March, 1801, ſome women were hired to take up with a bricklayer's trowel plants of wheat from another field, where the crop was very luxuriant. Theſe were planted into the vacant ſpaces by children, large holes for them being previouſly made by the handle of a ſpade, pointed at its end. The children were watched very attentively, making them arrange the roots of the plants, and with a ſtick break the edges of the holes, that the mould might cover them. Wet weather was purpoſely ſelected for the occaſion; but it proved ſo wet, that they were delayed for more than a week; during the whole of which time two or three wheelbarrows full of plants were lying expoſed on the tumbril ready for inſertion. Theſe plants were uſed, not without ſome apprehenſion. The tranſplanting was not concluded till the 21ſt of the month (March). At harveſt-time it would have been impoſſible to have diſtinguiſhed the tranſplanted from the drilled wheat, but that the plants of the former were placed conſiderably wider from each other. It is imagined, from recollection only, that the plants, on an average, formed ſquares of from twelve to fourteen inches with each other. They branched abundantly, and bore well; the ears were as numerous and as heavy as the drilled wheat. There were certainly four acres tranſplanted. The expenſe of the buſineſs cannot be well eſtimated, becauſe of its irregularity in this particular caſe. At the time it was tranſplanted, wheat ſold at about ſixty-five ſhillings per coomb. Two buſhels an acre would have been inſerted, and the ſetting, on account of the irregularity, would certainly have been twelve ſhillings per acre.

	£.	s.	d.
Setting four acres, at 12s. - -	2	8	0
Two coombs of ſeed, at 65s. - -	6	10	0
	8	18	0

It is not believed that the expenſe of the undertaking much exceeded a fourth part of this. It is ſuppoſed that the whole buſineſs of tranſplanting might be done for thirteen or fourteen ſhillings an acre; and one acre of ſeed plants would ſuffice for a great many acres. When the plants are taken from a crop which is intended to remain, the holes which the trowel makes ſhould be preſſed down with the foot, in order that they may be filled with earth, and not expoſed to drought or too much wet. In trying experiments of this ſort, it is beſt not to venture on too large a ſcale at firſt.

To be read after Line 18, *Page* 573.—Ploughing but once for ſummer corn has however been adviſed by ſome: this practice, it has been obſerved by an intelligent farmer, though certainly not general in the county of Norfolk, is yet by no means uncommon. His crop of barley was never more abundant than it was laſt year from a ſingle ploughing. He has now between forty and fifty acres, which have the appearance of being very productive at the enſuing harveſt, not one acre of which has been ploughed twice. This practice certainly ſaves expenſe, ſaves time, and is very ſimple. He does not, however, mean to recommend it merely becauſe he adopts it himſelf; every man muſt be guided by circumſtances: if his land is foul he muſt clean it, and frequent ploughing is at once the cheapeſt and moſt effectual method he can purſue. If, however, the land be thoroughly cleaned by the uſual laborious preparation for turnips, it cannot be very foul for barley or oats, one of which is moſtly the ſucceeding crop; and he ſuſpects the neceſſity of frequent ploughings for ſummer corn is generally attributable to the ſlovenly injudicious manner in which the ſummer leys for turnips have been managed*.

Without venturing to recommend the practice, a Norfolk farmer ſtates a fact: In the year 1800, he ſowed between forty and fifty acres of barley upon turnip land ploughed only once, and thraſhed ſomewhat more than eleven coombs:—three buſhels per acre. This was in the year of ſcarcity. In 1801, he grew only twenty-four acres of barley; about half of which was drilled, the land having been previouſly pulverized by repeated ploughings, the other half *once* ploughed only, after the turnips were off. The reſult was much in favour of the broad-caſt barley: but it ſhould be obſerved, that the drill did not deliver the ſeed with ſufficient regularity:—he grew eight coombs:—two buſhels round. The year following he ſowed forty-two acres of barley broad-caſt: wanting to bring his land upon ſmaller ridges, he *worked it about:* the crop of barley was very great. He has already thraſhed about ten coombs per acre, and calculates that he has between two and three coombs per acre yet in the ſtraw.

By his advice, his tenant has this year ſown almoſt his whole barley crop with a ſingle ploughing; his turnip-land being clean, with the exception of one piece, which he was adviſed to plough ſeveral times. The weather having continued remarkably dry was the reaſon of the recommendation. By ploughing land two or three times and harrowing it as often in dry weather, whatever moiſture there is muſt evaporate. Corn depoſited in land in this ſituation comes up at two different times; the ſuperficial corn, that which being lightly buried feels the influence of

* Monthly Magazine, Vol. X. p. 132.

dews, and ſprouts up: that which lies deeper will not germinate till a ſhower of rain comes. At harveſt time one half of the farmer's crop would be ſhelled before the other would be ripe. The year before, the ſeed-time was *dropping* as the farmers call it, or he ſhould not have worked his land ſo much about.

To be read after Line 31, *Page* 575.—In oppoſition to an opinion ſtated by Mr. Kerrich, that "out of a coomb of diſcoloured barley, more than two buſhels will not in moſt inſtances work on the malting floor;" and that he is of opinion, it cannot be relied upon for ſeed, "*as the ſeeds do not vegetate better in the ground than they do upon the floor:* an intelligent Norfolk farmer determined to try the vegetative powers of barley in different tints of diſcoloration; and found, as he expected, that the mere circumſtance of diſcoloration had nothing to do with the proceſs of germination when the ſeed is committed to the ground. If the corculum, the ſpeck of vitality, be not injured, the ſeed, he believes, will invariably germinate: the cotyledons are merely organs of nutrition, which convey the oily farinaceous matter of which they are compoſed, to the infant plant: if the nutritious ſubſtance be liberally communicated, which we ſuppoſe to be the caſe when the cotyledons are large, plump and firm, the plant, it is obvious, will thrive better and more rapidly, than when the cotyledons, ſhrunk and ſhrivelled, diſtribute a parſimonious mucilage. Still, however, the deficiency of natural nouriſhment in this latter caſe may, he is perſuaded, be in a great meaſure ſupplied by imparting an additional fecundity to the ſoil. He ſelected from a heap of barley, which lay in his barn, twenty kernels, the moſt thin and meagre which he could find; this was during the ſevereſt part of winter. He planted them in ſome very rich mould, and kept the pot in his ſtudy; where every one of them germinated, tardily indeed at firſt, but the radical fibres ſoon ſpread, and the plants grew luxuriantly. In his garden he afterwards planted ſome of the blackeſt barley he could find, a large proportion of which grew, and was healthy: the corculum of ſome few kernels had been injured, probably rotted by exceſſive rains, and thoſe kernels made no effort to germinate.

In contradiction of the ſecond poſition, he picked from the floor of a neighbouring maltſter ſixty kernels of barley, which having been in the heap (as he was aſſured by him) for nineteen days, had refuſed to malt. He told him, perhaps truly, that thoſe kernels would certainly not vegetate, however long they remained on his floor. He planted them in his garden: and out of ſixty, forty-five grew as rapidly and vigorouſly as he ever ſaw barley in his life. In ſhort, it is evident that warmth and moiſture, however eſſential to germination, are not of themſelves ſufficient to

induce it. Is it not probable, ſays the experimenter, that the corculum of theſe kernels which refuſed to germinate on the floor, was ſtimulated into action by the larger proportion of oxygen which the mould of the garden contained? If ſo, and the fact is very eaſily aſcertained, the maltſter is not ſo much at the mercy of the ſeaſons as Mr. Kerrich would lead us to imagine: he may ſurely contrive to impart a portion of oxygen to his malt-heap without much difficulty, and without much expence.

Encouraged by the ſucceſs of his little experiments on the growth of diſcoloured barley, he ſold his brighteſt corn, and truſted his whole crop to the moſt ordinary and the darkeſt ſeed he had. And the preſent appearance of his crop, conſiſting of more than forty acres, gives him reaſon to expect an abundant produce. Although barley will grow in the ground after having received conſiderable diſcoloration, nay after an incipient germination has taken place in the ear as it has lain on the ground, yet it certainly may be ſo injured as to be very unſafe for ſeed. He agrees, therefore, with Mr. Kerrich in earneſtly recommending to thoſe, who at any future ſeaſon may be diſpoſed to ſow dark barley, "firſt to try a ſmall quantity of what they may reſerve for ſeed, that they may aſcertain whether it will grow or not, before they ſow their general crop*."

* Monthly Magazine, Vol. X. p. 132.

END OF THE FIRST VOLUME.

R. Taylor and Co., Printers, Black-Horse Court, Fleet Street.

ERRATA.

Page 32 Line 1, *for* Cor *read* Cort
182 —— 4, — fully *read* full
206 —— 9, — is *read* are
225 —— 18, — *the same error*
362 —— 15, — † *put* ‡, (*in which cases the references will be right, and the note* † ibid. *will regard the note* *)
362 —— 30, *for* is *read* are
363 —— 19, *from bottom, the same error*
393 —— 17, *for* † *place* ‡
443 —— 9, *from bottom, for* prevent *read* preventing
554 —— *last but* 2, *for* salt *read* sand
556 —— 23, *for* tomil dew *read* to mildew
557 —— 11, — and that in as *read only* and in a
662 —— 9, — tuta *read* ruta
709 —— *note* *, *for* Dancus *read* Daucus
740 —— 25, *for* crops have *read* crop has
744 —— 5, *note, for* closes *read* clauses
751 —— 23, *for* craw *read* crow
917 —— 14, — grass, husbandry *read* grass-husbandry.

5'5'

BSB Bayerische StaatsBibliothek
MDZ Münchener DigitalisierungsZentrum Digitale Bibliothek

Dickson, R. W.

Practical agriculture; or, a complete system of modern husbandry with the methods of planting, and the management of live stock ; in two volumes

Bd.: 1

London (1805)
4 Oecon. 78-1
urn:nbn:de:bvb:12-bsb10228573-7